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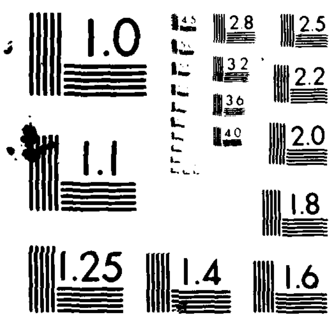

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DEVELOPMENT OF A HACS USER INTERFACE MODULE

FINAL REPORT

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16. Abstract

DEVELOPMENT OF A HACS USER INTERFACE MODULE

The Hazard Assessment Computer System (HACS) is one of six major components of the U.S. Coast Guard's Chemical Hazards Response Information System (CHRIS). HACS is a computerized system consisting of chemical spill models and containing all necessary physical and chemical property data to permit hazard assessments to be performed for 900 commonly shipped chemicals. The User Interface Module (UIM) provides for fully interactive operation of HACS with remote access for users to the central computer facility by means of remote terminals. The final report provides documentation of the internal structure of the HACS/UIM as developed for use by the USCG on the Cybernet System of Control Data Corporation. The UIM controls the user interaction with HACS by means of a question and answer dialog; all user responses are interpreted by the UIM without input formatting restrictions using a series of terminal input utility functions. An overview of the internal structure of HACS/UIM is given in terms of both sub-program modules and sequence of operations. Descriptions of all required HACS data files are given; these include a chemical and physical property data file for the 900 hazardous chemicals. Additional descriptive text and detailed input data explanations are stored in external files for retrieval and display under user control. Complete program listings for the HACS/UIM and associated computer programs are included in the report.

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HAZARD ASSESSMENT
COMPUTER SYSTEM

"DEVELOPMENT OF A HACS USER INTERFACE MODULE"
FINAL REPORT

30 September 1981

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1. INTRODUCTION

The Chemical Hazard Response Information System (CHRIS) is designed to provide timely information essential for proper decision-making by responsible Coast Guard personnel and others during emergencies involving the water transport of hazardous chemicals. A secondary purpose is the provision of certain basic non-emergency-related information to support the Coast Guard in its efforts to achieve improved levels of safety in the bulk shipment of hazardous chemicals.

CHRIS consists of four reference guides or manuals, a regional contingency plan, and a hazard assessment computer system (HACS). The four manuals contain chemical data, hazard assessment methods, and response guides. Regional data are included in the Coastal Regional Contingency Plans. Elements of the Coast Guard Headquarters staff operate the hazard assessment computer system and provide technical assistance on request by field personnel during emergencies. In addition, they are responsible for periodic update and maintenance of CHRIS. A brief description of each major component of CHRIS is provided in Section 2 of this report.

This report documents the internal computer program structure of the Hazard Assessment Computer System (HACS) as it operates on Control Data Corporation's Cybernet Service with the User Interface Module (UIM). A second report, the HACS/UIM Users' Operation Manual, contains additional information which, although not duplicated in this report, is useful for understanding the internal operation of the HACS/UIM. A third report, the HACS Program Reference Manual, contains detailed technical documentation of the earlier batch version of the system as it operated on the CDC 3300 computer at USCG Headquarters; although the batch operation has now been replaced by an interactive mode, much of this earlier documentation gives useful background on the current internal structure of the HACS/UIM.

HACS is comprised of a specific set of hazard assessment models, chemical specific data, and an overall system structure to provide data control and output displays. Two separate computer programs are used to define and produce independent displays of the chemical specific data; the use and capabilities of these programs are described in separate reports.

Also to assist in obtaining the compound recognition code used to reference data for a particular chemical, a separate set of indices have been produced and are given in a separate report. These indices enable a user of HACS to obtain a recognition code for a chemical given either the compound name or a synonym.

In addition to the file of chemical specific data, HACS uses another independent set of data referred to as the default file. Default file data is used by HACS during execution to define the structure of internal HACS processing files. The elements and current data contained in the default file are described in the HACS User Reference Manual. The HACS default file provides the primary control within the UIM for interactive requests for

user input data.

The individual hazard assessment models contained in HACS are basically organized as separate programs, arranged as overlays, which are retrieved and executed under the control of the HACS executive system. Each separate program includes a framework within which data items (environmental conditions, chemical properties, model parameters, user options, etc.) are transferred from HACS data files to the rate model, and results obtained from model computations are stored in HACS files. The program code for the individual assessment models, and associated subroutines, is included in this report, however, the theoretical basis for these models is described in Assessment Models in Support of the Hazard Assessment Handbook published by the U.S. Coast Guard in January 1974. A later report entitled "Development of Additional Hazard Assessment Models" describes new models developed and incorporated into HACS during 1976.

This manual assumes a thorough familiarity with the contents of the HACS User Reference Manual, and uses the principles of operations described in that manual as the basis for technical documentation of the internal program structure.

Most HACS program code is written in Fortran IV, avoiding machine dependent features or coding as much as possible. However, the development of the UIM and associated capabilities for the operation of HACS, and the extended file storage requirements for explanatory text, have required a greater use of specialized coding than was necessary with earlier versions of HACS. The purpose and function of these portions of HACS are described in the detailed program listings; for operation of HACS on other computer equipment, changes in programming syntax will be necessary to preserve the same functions.

In overview, HACS consists of:

(1) A large operating program for the HACS/UIM,

(2) A set of procedures used on Cybernet for program execution and supporting operations, and

(3) A set of additional computer programs which provide supporting functions primarily for maintenance or conversion of data files used by the HACS/UIM.

Sections 3 and 4 of this report contain general information regarding the current structure and operation of the HACS/UIM. Section 5 contains the detailed HACS/UIM computer program listings, each with narratives and identification of all internal variables or parameters. Section 6 gives a brief description of the procedure used on Cybernet to run the HACS/UIM; details of the use of Cybernet services for editing, program compilation and other similar operations required for program development are beyond the scope of this report. Details of the additional supporting computer

programs which were prepared during the UIM project are given in Section 7. This section contains statements of program purpose and function, and complete program listings are included.

The HACS/UIM has evolved through a series of stages in which additional desired features have been identified as experience with the interim versions of the UIM has been gained. Readers of this report are cautioned that the HACS/UIM is a dynamic system, and changes are being made continually in response to new desired features or system capabilities, to new computer operations or use within the Coast Guard, and to requirements which result from other related Coast Guard projects. (For example, the preparation of chemical specific physical property estimates will lead to a significant re-structuring of the HACS physical property interface.) Thus the program listings as contained in this report can only document the system at one particular stage in its development.

2. COMPONENTS OF THE CHEMICAL HAZARD RESPONSE INFORMATION SYSTEM (CHRIS)

2.1 A Condensed Guide to Chemical Hazards (COMDTINST M16465.11)

The Condensed Guide contains information needed to help personnel make the proper response in an emergency situation; it is the only CHRIS handbook that will be carried to the actual scene of an accident. It is intended for use by port security personnel and others who may be the first to arrive at the site of an accidental discharge or fire and who need readily available and easily understood information about the hazardous properties of the chemical involved. It will be used to determine the proper actions that should be taken immediately to safeguard life and property and to prevent contamination of the environment.

COMDTINST M16465.11 briefly describes the chemical and biological hazards of various materials so that personnel at the scene of an accident can assess the danger and consider the appropriate large-scale response. It also lists the on-scene information needed for proper use of the Hazard Assessment Handbook (COMDTINST M16465.13). Selected information on each chemical covered by CHRIS is summarized from the more extensive material in the Hazardous Chemical Data Manual (COMDTINST M16465.12) and is presented on a single page.

2.2 Hazardous Chemical Data (COMDTINST M16465.12)

This manual is the cornerstone of CHRIS. For each substance, it lists the specific chemical, physical, and biological data needed for the preparation and use of the other components of the system. It can also be used after the initial response action, when there is sufficient time to use more detailed information than that found in COMDTINST M16465.11. The first of the six pages devoted to each chemical is a duplicate of the corresponding page in COMDTINST M16465.11.

COMDTINST M16465.12 is intended for use primarily by the On-Scene Coordinator (OSC) and by Regional and National Response Centers for devising, evaluating, and carrying out response plans.

Much of the quantitative information found in COMDTINST M16465.12 is needed for the hazard assessment calculations described in the Hazard Assessment Handbook (COMDTINST M16465.13). COMDTINST M16465.12 contains the so-called Hazard Assessment Code, which directs the user of COMDTINST M16465.13 to the appropriate calculation procedures of hazard assessment. COMDTINST M16465.12 also suggests general responses to an accidental discharge, which summarize the detailed information given in the Response Methods Handbook (COMDTINST M16465.14).

2.3 Hazard Assessment Handbook (COMDTINST M16465.13)

The Hazard Assessment Handbook describes procedures to be used for estimating the quantity of a hazardous chemical that may be released

accidentally during shipment. It also describes how to estimate its concentration in air and in water as a function of time and distance from the discharge. Methods for predicting the resulting toxicity, fire, and explosion effects are also described. The calculations use data from COMDTINST M16465.12.

2.4 Hazard Assessment Computer System

The Hazard Assessment Computer System (HACS) is a computerized version of COMDTINST M16465.13. It permits trained headquarters specialists to obtain very detailed hazard evaluations quickly, when requested by OSC personnel.

In addition to computer models for hazard assessment computations, HACS includes several related computer based systems such as the physical property update and data retrieval programs, and the chemical compound name and synonym cross-reference programs. Although HACS and COMDTINST M16465.12 are based on the same original body of data, differences may occasionally arise because HACS is more readily updated than the printed manual.

2.5 Response Methods Handbook (COMDTINST M16465.14)

The Response Methods Handbook is written specifically for Coast Guard OSC personnel who have had some training or experience in hazard and pollution response. The handbook describes cautionary and corrective response methods for reducing and eliminating hazards that result from chemical discharge.

Although several types of response are suggested in COMDTINST M16465.12, the specific response, to be chosen from among those described in COMDTINST M16465.14, should be determined by the results of the hazard assessment procedures in COMDTINST M16465.13.

2.6 Data Base for Regional Contingency Plan

The Coast Guard's Regional Contingency Plans, although not considered a part of CHRIS, are an important adjunct to the system. Each Regional Contingency Plan contains a section (Annex XX) that presents data on a specific region, sub-region, or locale. These data, which are intended for use by OSC personnel, include such information as the following:

- An inventory of physical resources and strike forces;
- Vulnerable or exposed resources (critical water-use areas);
- Potential pollution sources;
- Geographic and environmental features;
- Cooperating organizations; and
- Recognized experts with identified skills.

3. OVERVIEW OF INTERNAL PROCESSING

The HACS/UIM is composed of a number of different program components; these include:

- Executive system - to control the overall sequence of operations, to provide utility functions for assessment model use, and to control the method of assessment model operation with the UIM (i.e., user input and model summary modes).

- Assessment models - a series of separate computer programs retrieving required data from the HACS state file, performing the indicated assessment computations, storing computed values in the state file for subsequent use and generating displays of computed results at the user terminal.

- Overlay control - used by the HACS executive system to select and execute the appropriate portion of the computer program, segmented into overlays, for each step required in an assessment computation.

- Input sequence control - to control the initialization of the HACS state file, user specification of the chemical recognition code and hazard assessment path code, and user selection of output display units.

- Property data processor - to retrieve requested data from the property file, perform unit conversions to internal HACS CGS units, to compute values of functions of temperature, and to transfer chemical specific property data to the HACS state file.

- Terminal input processing - a series of related functions to perform the reading of user entries typed at a terminal in a free format mode, and either transfer the resulting values to other portions of HACS or issue diagnostic messages to the user terminal and process corrections.

- State file interface - a series of routines which control the transfer of data values between the HACS state file and the hazard assessment models. For the UIM, these routines perform additional functions to enable an assessment model, when accessing the state file to obtain a data value not yet entered, to initiate an interactive request to the user terminal to obtain the value. Similarly, the interface also provides for the summary of model input values prior to the execution of the model.

- Message processing - to enable HACS to access external files of descriptive explanations for individual data items, hazard assessment models and hazard assessment scenarios.

- Code interpretation - a series of generalized routines used to translate packed codes from external file structures to forms for internal HACS use. These routines were developed to permit compaction of HACS' external file storage requirements.

- Printer plotting - routines provide a generalized utility producing graphic displays at the user terminal. All scaling functions are performed automatically, and are based on the magnitude of the data points displayed to obtain even or uniform axis labeling. The off-line plotting capability formerly contained in HACS Overlay 2 has been obsolete for some time, and has been deleted from the UIM version.

These components utilize a number of both internal and external files in their operations:

- Program file - a permanent disk file containing pre-compiled HACS program code in overlay and segment structure. The HACS executive system automatically accesses this file to load portions of the HACS program code into computer memory for execution as required.

- State file - an internal program file constructed by HACS during an assessment run; provides data base storage for all user input, property, default and computed data items utilizing a data quality priority structure.

- Default file - a permanent disk file defining the structure of the HACS state file, and containing estimated values for HACS data items to be used only in the absence of any other value.

- Chemical properties file - a magnetic tape file containing predefined physical property data for 900 hazardous chemical substances.

- Save file - an internal program file containing a copy of a HACS state file after completion of user input operations. Permits HACS re-runs requiring only new input values to be used.

- Message files - three external files which contain coded or uncoded variable length text descriptions of HACS data fields, assessment models and assessment scenarios.

- User terminal - although not actually a file in the usual sense, the user terminal is the source of input data requested interactively by the UIM during a hazard assessment computation.

Further descriptions of the functions of these files is contained in Section 2 of the HACS/UIM Users' Operation Manual; additional detailed information regarding file structure and other characteristics is given in Section 4 of this report.

3.1 Overlay Structure

Due to the amount of program code contained in HACS, and memory limitations on the CDC 3300 computer system, the batch version of HACS originally installed at USCG Headquarters consisted of a series of program overlays that are loaded into memory and executed as needed under the control of the HACS executive system. The overlay structure was transferred when HACS was installed on Cybernet, and remains in the UIM version. An over-riding consideration in the design of the overlay structure was the anticipation of future modifications, enhancements or even replacements that might develop as a result of advances in hazard assessment technology. Also the fact that HACS is constructed to proceed along <u>any</u> user specified path of the hazard assessment event chart led to establishing individual rate models within separate overlays.

Overlay capabilities are defined for 3 levels. The main or root overlay, 0, is resident at all times and uses a system utility to load and execute any one of a multiple number of second level overlays. Each of these may, in turn, load and execute any one of a multiple number of third level overlays which are referred to as segments. Each overlay or segment is executed as a separate program. Subroutines resident in a higher level overlay may be referenced. On completion of the execution of the separate overlay or segment program, control returns to the higher level overlay immediately following the location at which control was transferred to the completed overlay or segment.

Overlay 0 contains the program and subroutines comprising the HACS executive system and is resident during all stages of a HACS run. In addition, overlay 0 contains a number of utility routines and library functions used by the rate models, system I/O routines and the overlay and segment control functions. Overlay 1 contains both the input sequence control and property data processors; overlay 2 contained the off-line plot generator and has been deleted.

Assessment rate models are contained in the remaining overlays, 3 to 8. Overlays 3 and 6 contain only a single rate model each. The first part of each of these overlays is coded as a main program which performs the functions of retrieving model input from the HACS state file, calling the appropriate rate model subroutines to perform the indicated assessment computations, then storing the results of these computations in the HACS state file.

Overlays 4, 5 and 7 each contain a multiple number of related, or independent rate models. For each of these, a separate main program exists to interface with the HACS executive system to select the appropriate rate model for execution. Then the first part of each individual model, coded as a subroutine, performs the functions of HACS data base I/O and executes the particular sequence of assessment computations.

Overlay 8 is a small control program, with resident multi-use routines for assessment computations, used to branch to one of six segment level

overlays. Each of segments 1, 3, 4, 5 and 6 are organized in a manner similar to overlays 3 and 6. That is, a separate program provides HACS data base I/O, then subroutines in the segment are called to perform the particular assessment computations. Note that these subroutines may in turn call multi-use subroutines in overlays 8 and/or 0. Segment 2 contains a separate main program to select between models K and P. Each of these models is then controlled by a subroutine which provides separate HACS data base control.

Internal HACS data files are resident in overlay 0.

3.2 Sequence of Operations

The basic HACS functions are to process user inputs to select available options or to enter data values, execute rate models, and display the results of these computations at the user terminal. These operations are sequenced internally by the executive system resident in overlay 0 which first executes overlay 1 to initiate the user input operation for chemical and hazard assessment path selection. When the user entry of the chemical recognition code has been read, HACS automatically accesses the external physical properties file and retrieves the corresponding data record. The chemical property values are uncoded, converted and stored in the HACS state file for later use. Also, at this stage, the codes for appropriate models and scenarios for the chemical are retrieved from this file, and used to control optional displays which can be requested by the user. During the input sequence which occurs in overlay 1, the HACS state file is initialized with default values, and on return to overlay 0 the state file contains only default and chemical property values.

Next, the HACS/UIM uses the user specified list of hazard assessment model codes and proceeds to execute each model by calling the appropriate overlay. The HACS executive initializes a flag for each model to a value of zero; after each execution the flag is set to 1 so that the first execution of each rate model can be identified. As each model is executed a series of subroutine calls are processed to obtain the necessary model input values from the HACS state file. In the state file interface portions of the system, if the value in the state file is a default value and if the model is being executed for the first time, the HACS/UIM does not use the value in the state file but instead issues a prompt at the terminal to obtain a value from the user. User responses (input of a value, query for the current value, or request for description) are processed, and this procedure is repeated for each data item until all model inputs have been obtained. The HACS/UIM then prints a summary of the model input values (by re-executing the model itself a second time), and provides an opportunity for the user to change any previously entered value. If any changes are made, the model input summary is repeated before the hazard assessment computation is done. Following the computation and display of results, the HACS executive processes an optional user request to re-run the model. In this case the user prompts for data input are suppressed, and the model input summary is displayed.

Each hazard assessment model is similarly executed until all models requested by the user have been run. The HACS/UIM then processes a user option to obtain displays of selected values from the HACS state file and the basic run is completed. In overlay 0 and then overlay 1, further user input responses determine whether a new run is initiated or further operation of the program is terminated.

The HACS/UIM Users' Operation Manual contains additional summary discussion of the processing steps of a HACS/UIM run, and a complete description of the terminal displays produced during a typical run.

4. HACS DATA FILE STRUCTURES

HACS utilizes several external and internal files for input data manipulation and storage during operation, in addition to fixed internal data items used for unit label interpretation, output reporting, etc. These files are identified and described below in detail where appropriate or by reference to other documentation.

4.1 Chemical Properties File

The chemical properties file is an external file of physical property data which may be accessed on either magnetic tape or disk; the file currently contains properties for 900 compounds, although additional compounds are expected to be added in the near future. Due to the length of this file, the original version of HACS utilized binary rather than source data formats. This machine dependent format has been retained throughout all later versions of HACS and requires separate translation programs to move copies of the property file from machine to machine.

A detailed description of the original file structure is given in the report "HACS Physical Property File Update and Maintenance - User and Technical Program Documentation."

For use with the UIM, two significant changes have been made to the property file format. First, the hazard assessment model codes originally entered on the file were used to create chemical specific codes for both models and scenarios, and these codes are now contained on the file. Second, a substantial portion of the data elements contained in the file are missing (i.e., not available or not pertinent), and a coding scheme has been used to further compact the file.

The version of the UIM described in this report uses a property file consisting of a header record followed by 900 data records, one per chemical. The header record format has not been changed. Each data record however is now treated as a variable length record, having a maximum length of 84 words. A third record structure, consisting of variable length logical records packed into fixed length physical record blocks, has been developed for use on machines not having the required variable length record facilities (see Section 7).

The variable length record format used by the current version of the UIM operating on Cybernet is described below:

Record Element	Description
1	Chemical recognition code, three letter code in integer word.
2 - 6	Chemical name, up to 40 characters in length stored as 8 characters per word in integer format.

Record Element	Description
7	Hazard assessment model codes applicable to particular chemical, stored as single bit settings in single integer word; uses 29 positions in word. Codes are 0 = model not applicable, 1 = model applicable.
8	Scenario codes, stored as single bit settings to correspond to internal HACS data list of scenario codes (e.g., bit 5 set to 1 indicates HACS scenario 5 is applicable).
9 - 13	Property value status codes, stored as 2 bits per code, 15 codes per word. Codes are 0 = missing, 2 = estimate, and 3 = exact. If code for item I is given as 0, then that item does not appear in following data.
14 - 84	Space for up to 71 data values for chemical, starting with molecular weight. All missing values are removed, so that positions 14, 15, etc. contain only actual data values. Excess space remaining, if any, at end of record is truncated giving variable length records (length is determined by number of data items actually present).

4.2 Default/State/Save Files

The HACS default file is a 2489 word external disk file written in binary mode from internal array storage. The HACS state and save files exist internally in HACS common areas and are simply arrays for data storage.

The structure and data organization of these three files are identical, and contain data values for HACS fields at different stages of processing. The default file is used to initialize the HACS state file. Field data values are stored in the HACS state file according to the attributes or characteristics of the field, and these characteristics are also defined by the default file.

The internal representation of the HACS state and save files are defined by the arrays stored in the common area /BASE/; refer to the listing of program HACS. Using the elements of the HACS state file for reference, the structure of each of these 2489 word files is as follows:

Identification	Length (Words)	Description
MSG(10)	10	80-character file label
MNF/MNI	2	Maximum file size allocations MNF = maximum number of real data fields MNI = maximum number of integer data fields
NF/NI	2	Actual file size utilized NF = number of real data fields NI = number of integer data fields
LIST(275,6)	1650	Contains six integer words of control data for each of up to a maximum of 275 data fields (see below).
FVAL(225,3)	675	Contains a value, minimum limit and maximum limit for up to 225 real data fields
IVAL(50,3)	150	Contains a value, minimum limit and maximum limit for up to 50 integer data fields
	2489	= Total file length.

Data storage and retrieval operations from these files are governed by the contents of the array LIST(275,6), referred to as the field definition table. The first entry of this table is reserved for the chemical recognition code. For any field I, the entries in the table are:

LIST(I,1) = Field number

LIST(I,2) = Coded field specification which can be written in BCD form as C4-C3-C2-C1 where the characters C1 to C4 give the field specifications as follows:

IVAR = C4, specifies the field value data type as integer (0) or real (1)

ITYP = C3-C2, specifies the type of quantity governing input/output conversions of the field value as a two digit integer index in the range 01 to MTYP

ISRC = C1, specifies the source or priority code associated with the current value of the field, coded as:

0 missing
1 default
2 estimated property
3 exact property
4 computed value
5 user value
6 system value

LIST(I,3)
LIST(I,4)
LIST(I,5) = Up to twelve character field name used for output displays

LIST(I,6) = Index to entry in field data value arrays. Gives index to array IVAL if code C4 (above) is 0, or to array FVAL if code C4 is 1.

During a normal hazard assessment run, the only file items that are changed as a result of user and/or computed assessment operations are MSG, the source code C1 of the field definition table, and data values stored in array positions FVAL(I,1) or IVAL(I,1). All other elements of the state and save files are obtained initially from the default file and cannot be changed during any assessment run.

The various save and recall operations performed by HACS to enter data into, or read data from, these files are controlled by the field definition table, requiring the coding and uncoding of LIST(I,2) as defined below.

(a) Define field specification - given pre-determined values of IVAR, ITYP and ISRC for field I, the field specification array element is coded as:

LIST(I,2) = 1000*IVAR+10*ITYP+ISRC

which can also be written as:

LIST(I,2) = ISRC+10*(ITYP+100*IVAR)

Also, if the index stored in the last entry of the table is J = LIST(I,6), then the field values for field I are actually stored in:

if IVAR = 1 FVAL(J,1) = value
FVAL(J,2) = minimum limit
FVAL(J,3) = maximum limit

or, if IVAR = 0 $\begin{cases} \text{IVAL(J,1)} & = \text{value} \\ \text{IVAL(J,2)} & = \text{minimum limit} \\ \text{IVAL(J,3)} & = \text{maximum limit} \end{cases}$

(b) Update source code - to change the source code specification for the value of field I, from OLD to NEW, the field specification array element is manipulated as follows:

LIST(I,2) = LIST(I,2)-OLD+NEW

where both OLD and NEW are integer variables.

(c) Read field specifications - given an existing field number, the table element LIST(I,1) is searched until a match is found, and the field specification array element is uncoded by the following sequence:

```
IVAR = LIST(I,2)/1000
ISRC = 1000*IVAR
ITYP   (LIST(I,2)-ISRC)/10
ISRC = LIST(I,2)-10*ITYP-ISRC
```

where ISRC is also used for intermediate storage of the product 1000*IVAR.

All HACS database operations are controlled by the routines IRCL, ISV, FRCL and FSV which are used to recall or save integer or real field values. Calls to these routines are issued by the HACS assessment rate models and define as a literal in the calling argument list the field number to be saved or recalled.

Thus the definitions of field numbers and field data types (real, integer) in the default file are not arbitrary and must correspond exactly to the definitions established by the HACS program. The field type indicator, elements C3 and C2 of LIST(I,2), govern unit labeling and conversions and are not generally arbitrarily defined.

4.3 Data Field Explanations (11)

An external file, unit 11, is used to store text descriptions of each of the data item fields defined in the HACS state file. Individual field descriptions are displayed at the user terminal either during interactive user input, or as part of the final run summary.

The user reference to these messages is controlled either by the UIM, or, during changes to the model input summary, by the user entry of the HACS data item field number. These field numbers are the four digit integer reference numbers (1000 series, 2000 series, 3000 series and 4000 series) defined by the HACS default file and stored in the HACS state file. Within the state file, the data fields are stored sequentially, and the present

version of HACS contains 256 data items. Given a data item reference by field number, the HACS/UIM uses the internal state file for reference and obtains a message index number (1 to 256) from the sequential position of the data item in the state file. Records contained in the data field explanation file are then directly accessed by keying on the message sequence number.

Each record in the file may contain from 3 to 690 characters of data, and the first word of a record may contain a code for different types of messages. The minimum record length of 3 words is a restriction required for Cybernet processing (shorter records are padded with blank fill). Messages containing less than 690 characters of text are written as variable length records.

The file contains four types of messages:

(1) Uncoded records contain text which is displayed at the user terminal.

(2) Type 1 records contain only a code '1' followed by blanks. This code is automatically translated by HACS/UIM to a standard message referencing the user manual.

(3) Type 2 records contain only a code '2' followed by blanks. This code is automatically translated by HACS/UIM to a standard message referencing CHRIS Manual II.

(4) Type 3 records are a combination of uncoded records and type 2 records. They contain the code 3 followed by variable length text. In HACS, these messages provide for additional explanation or clarification of particular chemical property data items. They are processed by first displaying the message from the external file, followed by the standard type 2 CHRIS Manual II reference.

The message file is created using separate programs described in Section 7 of this report which insert Fortran format codes between each line of a message. When read by the HACS/UIM, appropriate opening and closing format characters are appended to the message text, and the messages are displayed using variable format output: WRITE(6,TXT).

4.4 Scenario Descriptions (12)

An external file, unit 12, is used to store text descriptions which are used to produce the scenario display selected by user option. The file contains a display header message, scenario descriptions and two display trailer messages.

The file contains 31 variable length, uncoded, text messages, each containing up to 690 characters of data. Messages 1 to 28 give

descriptions of each of the 28 different hazard assessment scenarios, and the messages correspond in sequence to an internal list of scenario codes contained in the HACS/UIM. Message 29 is the display header, and messages 30 and 31 give the display trailer.

The message file is produced by a variation of the program used to create the field text message file (refer to Section 7).

The records contained on the file consist of character strings giving individual lines of the message, each string separated by appropriate Fortran format control characters. These control characters are automatically inserted by the message file build programs (Section 7). When read by the HACS/UIM, appropriate opening and closing format characters are appended to the message text, and the messages are displayed using variable format output: WRITE(6,TXT).

4.5 Model Descriptions (13)

An external file, unit 13, is used to store text descriptions which are used to produce model explanations selected by user option. The file contains 29 messages, one for each model, and the message numbers correspond in sequence to an internal model code list contained in the HACS/UIM.

Each message is variable length, uncoded, and contains up to 1900 characters of data. The message file is produced by a variation of the program used to create the field text message file (refer to Section 7).

The records contained on the file consist of character strings giving individual lines of the message, each string separated by appropriate Fortran format control characters. These control characters are automatically inserted by the message file build programs. When read by the HACS/UIM, appropriate opening and closing format characters are appended to the message text, and the messages are displayed using variable format output: WRITE(6,TXT).

5. HACS/UIM PROGRAM LISTINGS

This section gives complete listings of all programs and subroutines comprising the HACS/UIM installed on CDC's Cybernet as of 20 April 1981, and may be subject to change based on the results of subsequent work.

The listings are given in the sequence in which the HACS overlay program files were established; programs and routines within overlay 0 are followed by programs within overlay 1 and so forth.

Generally, the listing of each routine provides a description of the overall function and method of operation of the routine, definitions of variables used, and commented processing sequences. File and data element structures are defined where primary references occur. In addition, the main program of the base overlay, PROGRAM HACS, and subroutine PROP of overlay 1 contain complete definitions of all common variables used.

```
      OVERLAY(UIMABS,0,0)
      PROGRAM HACS(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE9,TAPE10,
     1TAPE60=INPUT,TAPE61=OUTPUT,TAPE11,TAPE12,TAPE13)
C
C        PROGRAM HACS PROVIDES THE OVERALL CONTROLLING FRAMEWORK
C        EXECUTING THE HACS INPUT DATA PROCESSOR, SELECTED HAZARD
C        ASSESSMENT RATE MODELS AND THE OFF-LINE PLOTTED OUTPUT POST-
C        PROCESSOR.  THE CONTROLLING LOOP CYCLES UNTIL EITHER A FATAL
C        ERROR IS DETECTED IN THE INPUT DATA, OR AN END OF FILE IS
C        REACHED.  ALL OVERLAYS ARE RESTORED AS REQUIRED BY CALLS TO
C
C     SUBROUTINE OVLOD.  ERROR EXIT MODE IS TURNED ON BY COMPASS
C     ROUTINE *ERR*.  THIS ROUTINE WILL TRAP ALL EXECUTION ERRORS
C     TO A SUBROUTINE FCHCK WHERE A MESSAGE WILL BE OUTPUT
C     INDICATING THE ERROR AND THE OVERLAY IN WHICH IT OCCURRED.
C     EXECUTION IS THEN TERMINATED.
C
C        FBLNK  = DATA WORD SET TO ALL BLANKS (A8) USED TO INITIALIZE
C                    THE OUTPUT PAGE TITLE
C        I      = DUMMY FORTRAN INDEX
C
C        COMMON VARIABLES USED - ANG,DATE,EOF,IFRST,LNCT,LP,MODEL,MODNO,
C                                NOFF,NOP,NPG,OVLST,PLTYP,STCON,SVCON,
C                                TITLE
C
C        SUBROUTINES REQUIRED  - DYYR,FCHCK,LSTFL,OVLOD,PAGER,TRACE
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 19 FEBRUARY 1976
C
C
      COMMON/OVER/NOV,SEG
C
C
C     NOV = OVERLAY NUMBER CORRESPONDING TO ASSESSMENT RATE MODEL
C     SEG = SECONDARY OVERLAY NUMBER LOADED IN CORE
C
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1             NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER      UPTH
      REAL         MSG
      DIMENSION    STATE(2489)
      EQUIVALENCE  (STATE(1),MSG(1))
C
C
C        SAVE   = HACS SAVE FILE, CONTAINS SAVED DATA BASE IN SAME
C                    FILE STRUCTURE AS HACS STATE FILE
C        UPTH   = CONTAINS CURRENT VALUES OF PATH CODES AS READ FROM
C                    USER INPUT AND STORED LEFT JUSTIFIED IN UP TO 15
C                    INTEGER WORDS (A1 FORMAT)
C        STATE  = HACS STATE FILE CONTAINING ELEMENTS AND STRUCTURED
C                    AS DEFINED BY THE REMAINDER OF THIS SECTION -
C        MSG    = A 10 WORD REAL ARRAY GIVING AN 80 CHARACTER HACS
C                    FILE LABEL.  CONTENTS ARE COPIED FROM THE USER
C                    INPUT TITLE CARD.  FOR CREATING AND UPDATING HACS
C                    DEFAULT FILES, THIS TEXT SHOULD INCLUDE THE NAME(S)
C                    OF THE AUTHOR OF THE FILE AND DATE OF PREPARATION
C        MNF    = MAXIMUM ALLOWABLE NUMBER OF REAL FIELD VALUES,
C                    EQUIVALENT TO DIMENSION OF ARRAY FVAL
C        MNI    = MAXIMUM ALLOWABLE NUMBER OF INTEGER FIELD VALUES,
C                    EQUIVALENT TO DIMENSION OF ARRAY IVAL
C        NF     = CURRENT NUMBER OF REAL FIELD VALUES ACTUALLY STORED
C                    STORED IN FILE ARRAY FVAL
C        NI     = CURRENT NUMBER OF INTEGER FIELD VALUES ACTUALLY
C                    STORED IN FILE ARRAY IVAL
C        LIST   = FIELD DEFINITION TABLE DIMENSIONED AS LIST(MFLD,6)
C                    WHERE MFLD=MNI+MNF.  NUMBER OF DEFINITIONS ACTUALLY
```

```
C                       STORED IS GIVEN BY NFLD=NI+NF.  FIRST FIELD
C                       DEFINITION IS RESERVED FOR CHEMICAL RECOGNITION
C                       CODE - SEE NOTE BELOW.  FOR ANY FIELD I, THE
C                       ELEMENTS OF LIST ARE DEFINED AS FOLLOWS -
C
C                       LIST(I,1) = FIELD NUMBER
C                       LIST(I,2) = CODED FIELD SPECIFICATION STORED IN A
C                                   FOUR DIGIT INTEGER FORMAT C4-C3-C2-C1
C                                   WHERE -
C                                          C4 = INDICATOR FOR INTEGER (0)
C                                                OR REAL (1) FIELD VALUE
C                                          C3-C2 = TWO DIGIT INTEGER TYPE
C                                                     CODE IN RANGE 01 TO
C                                                     MTYP DEFINING TYPE OF
C                                                     PHYSICAL QUANTITY,
C                                                     ALSO USED AS INDEX
C                                                     CONTROLLING UNITS
C                                                     CONVERSION
C                                          C1 = FIELD VALUE SOURCE CODE
C                                                0 = MISSING
C                                                1 = DEFAULT
C                                                2 = ESTIMATED PROPERTY
C                                                3 = EXACT PROPERTY
C                                                4 = COMPUTED VALUE
C                                                5 = USER VALUE
C                                                6 = SYSTEM VALUE
C                       LIST(I,3) = ONE TO TWELVE CHARACTER FIELD NAME
C                       LIST(I,4)       USED FOR OUTPUT DISPLAYS, AND
C                       LIST(I,5)       STORED IN WORDS 3,4 AND 5 OF LIST
C                       LIST(I,6) = INTEGER POINTER, INDEX, TO ARRAYS FOR
C                                   ACTUAL FIELD VALUE, AND MINIMUM AND
C                                   MAXIMUM VALUE.  POINTS TO ARRAY IVAL
C                                   IF CODE C4 (ABOVE) IS 0, OR TO ARRAY
C                                   FVAL IF CODE C4 IS 1.
C                       IVAL(J,1) = VALUE OF INTEGER FIELD, LINKED TO FIELD
C                                   NUMBER IN LIST(I,1) BY INDEX IN
C                                   LIST(I,6), AND CODE C4 IN LIST(I,2)
C                       IVAL(J,2) = MINIMUM VALUE OF INTEGER FIELD
C                       IVAL(J,3) = MAXIMUM VALUE OF INTEGER FIELD
C                       FVAL(J,1) = VALUE OF REAL FIELD, SEE IVAL(J,1)
C                       FVAL(J,2) = MINIMUM VALUE OF REAL FIELD
C                       FVAL(J,3) = MAXIMUM VALUE OF REAL FIELD
C
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
C
C
C        PLTYP  = INTEGER CODE SET BY HACS RATE MODEL TO SELECT LOGIC
C                    FOR PRODUCING OFF-LINE PLOT TAPE FILE
C        XBX    = ARRAY USED TO PASS OFF-LINE PLOT DATA FROM RATE
C                    MODELS TO PLOT LOGIC.  DATA IS AVAILABLE IN XBX
C                    ONLY IMMEDIATELY FOLLOWING EXECUTION OF RATE
C                    MODEL AND IS OVERWRITTEN BY EXECUTION OF NEXT
C                    RATE MODEL.  EXCESS SPACE IN XBX IS ALSO USED
C                    FOR STORAGE OF ADDITIONAL DATA ARRAYS USED BY
C                    RATE MODELS.
C
C
     0COMMON/CNTRL/EOFF,ICD,IDFLT,LBL(4),LSTCN(3,3),MODEL(15),NOP,
     1            STCON,SVCON
      INTEGER     EOFF,STCON,SVCON
      REAL        LBL
C
C
C        EOFF   = INDICATOR SET TO -1 IF A SET OF USER DATA CARDS HAS
C                    BEEN TERMINATED BY AN END OF FILE, 0 OTHERWISE.
C        ICD    = CHEMICAL RECOGNITION CODE (A4) READ AS USER DATA
C        IDFLT  = FORTRAN UNIT NUMBER FOR EXTERNAL STORAGE OF HACS
C                    DEFAULT DATA FILE MANIPULATED BY SUBROUTINE ACCESS
C        LBL    = FOUR WORD ARRAY OF LABELS DESCRIBING TYPE OF HACS
C                    STATE OR SAVE FILES (1=EMPTY, 2=DEFAULT, 3=USER,
```

```
C                 4=COMPUTED)
C        LSTCN  = ARRAY USED TO STORE VALIDATED FILE DISPLAY OPTIONS
C                 BY REFERENCE NUMBER FOR USE IN SUBROUTINE LSTFL
C        MODEL  = ARRAY OF INTEGER RATE MODEL INDICES CORRESPONDING
C                 TO USER SPECIFIED PATH CODE LETTERS
C        NOP    = HACS OPERATION CONTROL VARIABLE DETERMINED FROM USER
C                 INPUT AS - 1 = RUN
C                            2 = RE-RUN
C                            3 = CONTINUE
C                            4 = LOAD DEFAULT
C                            5 = UPDATE DEFAULT
C        STCON  = INTEGER CONTROL FOR TYPE OF VALUES IN HACS STATE
C                 FILE (REFER TO DEFINITION OF ARRAY LBL)
C        SVCON  = INTEGER CONTROL FOR TYPE OF VALUES IN HACS SAVE
C                 FILE (REFER TO DEFINITION OF ARRAY LBL)
C
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
C
C        CONV   = ARRAY OF CONVERSION FACTORS STORED AS CONV(JSYS,ITYP)
C                 FOR EACH DEFINED TYPE (ITYP) OF PHYSICAL QUANTITY.
C                 THE SYSTEM INDEX JSYS = 1, 2, 3 CORRESPONDS TO
C                 UNIT LABEL INDICES ISYS = 2, 3, 4 SINCE CONVERSION
C                 FACTORS ARE NOT STORED FOR INTERNAL HACS UNITS.
C                 CONVERSION FACTORS ARE APPLIED AS FOLLOWS -
C                     (INTERNAL VALUE) = (INPUT VALUE) * CONV
C                 EXCEPT FOR TEMPERATURE CONVERSIONS WHICH ARE CON-
C                 TROLLED BY BRANCHING ON ITYP.
C        MSYS   = MAXIMUM NUMBER OF DEFINED SYSTEMS OF UNITS
C        MTYP   = MAXIMUM NUMBER OF TYPES OF PHYSICAL QUANTITIES
C        UNIT   = ARRAY OF FIELD VALUE UNIT LABELS (A8) STORED AS
C                 UNIT(ISYS,ITYP) FOR EACH DEFINED TYPE (ITYP) OF
C                 PHYSICAL QUANTITY AND SYSTEM OF UNITS (ISYS).  UNIT
C                 LABELS AND CONVERSION FACTORS ARE DEFINED FOR BOTH
C                 REAL AND INTEGER FIELDS, HOWEVER, NUMERIC
C                 CONVERSIONS ARE APPLIED ONLY TO REAL FIELDS. CON-
C                 VERSIONS FOR ANY TYPE QUANTITY MAY BE SUPPRESSED
C                 BY LEAVING THE APPROPRIATE DATA WORD IN UNIT BLANK.
C                 ALL UNITS HOWEVER MUST BE GIVEN FOR SYSTEM 1 WHICH
C                 SPECIFIES INTERNAL UNITS.  ON INPUT, DATA READ WITH
C                 A BLANK UNIT FIELD IS ASSUMED TO BE IN INTERNAL
C                 UNITS.  ON OUTPUT, VALUES ARE DISPLAYED IN ALL
C                 DIFFERENT NON-BLANK UNITS SPECIFIED.
C
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
C
C        DTE    = DATE OF PROGRAM EXECUTION DETERMINED AT RUN TIME
C        LNCT   = COUNT OF LINES PRINTED ON CURRENT LINE PRINTER PAGE
C        LNPG   = MAXIMUM NUMBER OF LINES PER LINE PRINTER PAGE
C        LP     = FORTRAN UNIT NUMBER FOR LINE PRINTER
C        NPG    = LINE PRINTER PAGE NUMBER
C        TITLE  = 80 CHARACTER USER INPUT RUN TITLE DISPLAYED AT THE
C                 TOP OF EACH OUTPUT PAGE.
C
C
      COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
C
C
C        ICVSL  = OUTPUT UNIT SELECTION OPTION RECALLED FROM HACS
C                 STATE FILE, VALUE IS 0 FOR ALL, OTHERWISE IS
C                 SYSTEM NUMBER (1=CGS, 2=SI, 3=ENG, 4=MXD)
C        IPRAC  = CONTROL OPTION TO SUPPRESS (0) OR TO SELECT (1)
C                 ACCESS TO THE HACS PHYSICAL PROPERTY DATA TAPE
C        IPRRP  = CONTROL OPTION TO SUPPRESS (0) OR TO SELECT (1)
C                 OUTPUT AUDIT OF HACS PHYSICAL PROPERTIES IF READ
C                 FROM PROPERTY TAPE
C        NOFF   = CONTROL OPTION TO SUPPRESS (0) OR TO SELECT (1)
C                 PRODUCTION OF DATA TAPE FOR OFF-LINE PLOTTING.
C                 IF SELECTED, DATA IS ACTUALLY GENERATED ONLY IF
```

```
C                   CERTAIN RATE MODELS ARE EXECUTED AND THE USER HAS
C                   REQUESTED PLOTTED OUTPUT OPTIONS FOR THESE MODELS.
C        NPRRP  = INTEGER SWITCH USED IN DATA BASE SAVE AND RECALL
C                   ROUTINES (FCNV ONLY) TO SELECT OPTIONAL OUTPUT
C                   DURING PROPERTY FILE INTERFACE
C
      COMMON/MODCN/MODEX(29),MODIO,LOCIO
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER      PTLST
C
C
C        PTLST  = DATA LIST OF ALL PATH CODES RECOGNIZED BY HACS, A TO
C                   Z, II, RR, SS AND BLANK, EACH STORED LEFT JUSTIFIED
C                   IN AN INTEGER WORD (A1 FORMAT).  THE SEQUENCE IN
C                   WHICH THE PATH CODES ARE STORED IS USED TO VERIFY
C                   THE SEQUENCE OF PATH CODES SPECIFIED BY THE USER.
C                   E.G., MODEL A MUST BE EXECUTED BEFORE MODEL B IF
C                   BOTH ARE SPECIFIED.
C        SOURC  = ARRAY OF LABELS DEFINING SOURCE CODES FOR FIELD VALUE
C                   DISPLAYS.  LABELS ARE STORED IN AN ARRAY INDEXED
C                   FROM 1 TO 7, CORRESPONDING TO SOURCE CODES INDEXED
C                   FROM 0 TO 6
C
C
      COMMON/OVCNT/MODNO,OVLST(29),SGLST(29)
      INTEGER       OVLST,SGLST
C
C
C        MODNO  = INTEGER INDEX FOR NEXT RATE MODEL TO BE EXECUTED,
C                   CORRESPONDS TO POSITION OF PATH CODE LETTER IN
C                   ARRAY PTLST AND HAS VALUES FROM 1 TO 30
C        OVLST  = SPECIFIED OVERLAY NUMBER CONTAINING CODE FOR ALL
C                   VALID RATE MODELS AS OVLST(MODNO) WHERE MODNO IS
C                   IN RANGE 1 TO 29
C        SGLST  = SPECIFIES SEGMENT NUMBER WITHIN OVERLAY FOR MODEL AS
C                   SGLST(MODNO) WHERE MODNO IS IN RANGE 1 TO 29.  A
C                   VALUE OF 0 IS STORED FOR ALL UNDEFINED SEGMENTS.
C
C
      COMMON/PLTCN/ANG,IBUF(4000),IFRST,IPLT,WIND
C
C
C        ANG    = SPECIFIES WIND DIRECTION FROM NORTH FOR USE IN OUTPUT
C                   LABEL ON OFF-LINE PLOT (NO LONGER IN USE).  VALUE
C                   OF 0.0 IS USED INSTEAD TO SUPPRESS COMPASS LABEL.
C        IBUF   = ARRAY USED BY OFF-LINE PLOT ROUTINES AS A WORK AREA
C                   FOR BUILDING TAPE RECORDS
C        IFRST  = CONTROL SWITCH SET TO ONE TO EXECUTE PLOT
C                   INITIALIZATION ROUTINES ON FIRST PASS ONLY.
C        IPLT   = FILE NAME USED FOR PLOT TAPE
C        WIND   = WIND VELOCITY OBTAINED FROM HACS DATA FIELD 2016
C
C
      EXTERNAL FCHCK
      INTEGER FLDTAB(257)
      INTEGER SCNTAB(32)
      INTEGER MODTAB(30)
      LOGICAL YESNO
      INTEGER ERRAY(6)
      DATA ERRAY/6*(-0)/,ERRAY(4)/0/
      DATA FBLNK/10H          /
C
C
C--------INITIALIZE VARIABLES IN COMMON STORAGE FOR RE-EXECUTION
      CALL OPENMS(11,FLDTAB,257,0)
      CALL OPENMS(12,SCNTAB,32,0)
      CALL OPENMS(13,MODTAB,30,0)
      REWIND 10
      CALL TRACE(0,0,0)
      NOV = 0
      SEG = 0
```

```
      CALL ERR(FCHCK)
      CALL SYSTEMC(115,ERRAY)
      ANG=0.0
      EOFF=0
      IFRST=1
      PLTYP=0
      STCON=1
      SVCON=1
C
C--------INITIALIZE OUTPUT PAGING ROUTINE
      CALL DATE(DTE)
      CALL TIME(TIM)
      WRITE(6,1020) DTE,TIM
 1020 FORMAT(//5X,33HHAZARD ASSESSMENT COMPUTER SYSTEM/
     1  5X,21HEXECUTION STARTED ON ,A10,4H AT ,A9//)
      LNCT=0
      NPG=0
      DO 5 I=1,10
    5 TITLE(I)=FBLNK
      DO 6 I=1,29
    6 MODEX(I)=0
      CALL PAGER(5)
      LOCIO=2
C
C--------RETURN HERE TO ACCESS HACS DATA INPUT PROCESSOR.  INITIAL CALL
C          TO FAULT CHECK ROUTINE INITIALIZES ERROR INDICATORS BEFORE
C          ENTERING OVERLAY.  INPUT PROCESSOR RETURNS NOP = 0 TO TERMINATE
C          OR NOP = 1,2 OR 3 TO EXECUTE ASSESSMENT RUN.
   10 CALL OVLOD(1)
C
C--------SKIP TO END IF USER OPTION CANCELLED, OR DOES NOT REQUIRE
C          EXECUTION OF RATE MODELS
      IF(NOP.EQ.0) GO TO 40
C
C--------LOOP ON RATE MODEL INDICES OBTAINED FROM USER PATH CODE
C          INPUT UNTIL INDEX CORRESPONDING TO FIRST BLANK IS FOUND.
C          EXECUTE OVERLAY FOR EACH MODEL.
      DO 20 I=1,15
      MODNO=MODEL(I)
      IF(MODNO.GE.30) GO TO 30
      NOV=OVLST(MODNO)
      IF(NOV.EQ.0) GO TO 20
   15 MODIO=MODEX(MODNO)
      CALL OVLOD(NOV)
      MODEX(MODNO)=1
      STCON=4
C
C--------TEST FOR SELECTION OF OFF-LINE PLOTTED OUTPUT
C     IF(NOFF.EQ.0) GO TO 20
C     IF(PLTYP.EQ.0) GO TO 20
C
C--------EXECUTE OFF-LINE PLOTTED OUTPUT POST-PROCESSOR
C     NOV = 2
C     CALL OVLOD(2)
C     CALL PAGER(3)
C     WRITE(LP,1010)
      WRITE(LP,1030)
      IF(YESNO(0)) GO TO 15
 1030 FORMAT (34H DO YOU WANT TO RE-RUN THIS MODEL?)
   20 CONTINUE
C
C--------TEST FOR FILE DISPLAY OPTION AFTER MODEL EXECUTION
   30 CALL LSTFL(3)
      CALL SUMRY
C
C--------RETURN TO INPUT DATA PROCESSOR IF AN END OF FILE HAS NOT
C          YET BEEN ENCOUNTERED, OTHERWISE TERMINATE RUN.
      IF(EOFF.EQ.0) GO TO 10
C
C--------END OF RUN
   40 CALL PAGER(5)
      WRITE(LP,1000)
```

```
      GO TO 50
C
 1000 FORMAT (//5X,15(1H*)/5X,15HEND OF HACS RUN/5X,15(1H*))
 1010OFORMAT (//54H MODEL OUTPUT WAS WRITTEN TO TAPE FOR OFFLINE PLOTTIN
     1G)
   50 CALL TRACE(1,0,0)
      END
      SUBROUTINE BEGPR(NAME)
C
C         THIS SUBROUTINE PRINTS A MESSAGE THAT INDICATES A RATE
C         MODEL IS BEING EXECUTED
C
C        SUBROUTINES REQUIRED  - PAGER
C
      COMMON/MODCN/MODEX(29),MODIO,LOCIO
      CALL PAGER(0)
      CALL PAGER(1)
      WRITE(6,1000) NAME
      CALL PAGER(3)
      IF(LOCIO.EQ.20) GO TO 10
      IF(MODIO.NE.0) GO TO 20
      LOCIO=1
      WRITE(6,1010)
      RETURN
   10 LOCIO=2
   20 WRITE(6,1020)
      RETURN
 1000 FORMAT (23H FOR EXECUTION OF MODEL,A4,1H,)
 1010OFORMAT (66H PREVIOUSLY UNSPECIFIED INPUT DATA, IF ANY, ARE REQUEST
     1ED BELOW...//)
 1020 FORMAT (37H THE SUMMARY OF INPUT DATA FOLLOWS...//)
      END
      BLOCK DATA
C
C        SUBPROGRAM GIVES INITIAL OR DATA VALUES FOR ALL VARIABLES
C        DEFINED IN LABELLED COMMON.  REFER TO MAIN PROGRAM FOR
C        DEFINITIONS OF EACH VARIABLE.
C
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 29 JANUARY 1976
C
C
     OCOMMON/BASE/MSGS(10),MNFS,MNIS,NFS,NIS,LISTS(275,6),
     1            FVALS(225,3),IVALS(50,3),UPTH(15),MSG(10),MNF,MNI,
     2            NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER     UPTH
      REAL        MSGS,MSG
      DIMENSION   SAVE(2489),STATE(2489)
      EQUIVALENCE (SAVE(1),MSGS(1)),(STATE(1),MSG(1))
C
     OCOMMON/CNTRL/EOFF,ICD,IDFLT,LBL(4),LSTCN(3,3),MODEL(15),NOP,
     1             STCON,SVCON
      INTEGER      EOFF,STCON,SVCON
      REAL         LBL
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER     PTLST
C
      COMMON/OVCNT/MODNO,OVLST(29),SGLST(29)
      INTEGER      OVLST,SGLST
C
      COMMON/PLTCN/ANG,IBUF(4000),IFRST,IPLT,WIND
     OCOMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
```

```
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      DATA BLANK/1H /,IN/5/,NO/1HN/,OUT/6/,YES/1HY/
     0DATA (SPLST(I),I=1,14)/1H0,1H1,1H2,1H3,1H4,
     1  1H5,1H6,1H7,1H8,1H9,1H+,1H-,1H.,1HE/
C
C
C--------IDENTIFY PLOT OUTPUT FILE
C
      DATA IPLT/4LIPLT/
C
C--------INITIALIZE SAVE FILE
C
     0DATA (MSGS(I),I=1,10)/10*10H          /,MNFS/225/,MNIS/50/,NFS/0/,
     1     NIS/1/,LISTS(1,1)/1001/,LISTS(1,2)/460/,(LISTS(1,I),I=3,5)
     2     /3*4H    /,LISTS(1,6)/1/,IVALS(1,1)/4H    /,IVALS(1,2)
     3     /4HN/A /,IVALS(1,3)/4HN/A /
C
C--------INITIALIZE STATE FILE
C
     0DATA (MSG(I),I=1,10)/10*10H          /,MNF/225/,MNI/50/,NF/0/,
     1     NI/1/,LIST(1,1)/1001/,LIST(1,2)/460/,(LIST(1,I),I=3,5)/3*
     2     4H    /,LIST(1,6)/1/,IVAL(1,1)/4H    /,IVAL(1,2)/4HN/A /,
     3     IVAL(1,3)/4HN/A /
C
C--------INITIALIZE PATH CODE INPUT ARRAY
C
      DATA (UPTH(I),I=1,15)/15*4H    /
C
C--------INITIALIZE AND SET DATA FOR OPERATIONS CONTROL
C
     0DATA EOFF/0/,IDFLT/10/,LBL(1)/8H EMPTY  /,LBL(2)/8HDEFAULT /,
     1     LBL(3)/8H  USER  /,LBL(4)/8HCOMPUTED/,STCON/1/,SVCON/1/
C
C--------SET DATA FOR UNIT CONVERSIONS.  NOTE THAT ADDITIONAL DATA IS
C        DEFINED AS NECESSARY IN SUBROUTINES FOR USE IN CONVERTING
C        TEMPERATURE VALUES (TYPE 06).  ALL OTHER CONVERSIONS ARE
C        APPLIED AS SCALE FACTORS.
C
      DATA MSYS/4/,MTYP/47/
C
     0DATA
     1 (CONV(I,  1),I=1,3)/1.0            ,1.0          ,1.0          /,
     2 (CONV(I,  2),I=1,3)/100.           ,30.48        ,160900.0     /,
     3 (CONV(I,  3),I=1,3)/1000000.0      ,28317.0      ,3786.09      /,
     4 (CONV(I,  4),I=1,3)/0.001          ,0.01602      ,1.0          /,
     5 (CONV(I,  5),I=1,3)/10.0           ,68950.0      ,1333.0       /,
     6 (CONV(I,  6),I=1,3)/273.15         ,32.0         ,273.15       /,
     7 (CONV(I,  7),I=1,3)/10000.0        ,929.0304     ,10000.0      /,
     8 (CONV(I,  8),I=1,3)/1000.0         ,453.6        ,907200.0     /,
     9 (CONV(I,  9),I=1,3)/0.0002389      ,1.0          ,1.0          /
C
     0DATA
     1 (CONV(I, 10),I=1,3)/0.0002389      ,0.55556      ,0.0002389    /,
     2 (CONV(I, 11),I=1,3)/1.0            ,60.0         ,3600.0       /,
     3 (CONV(I, 12),I=1,3)/1000.0         ,453.6        ,252.0        /,
     4 (CONV(I, 13),I=1,3)/1.0            ,0.01745      ,0.01745      /,
     5 (CONV(I, 14),I=1,3)/0.00002389     ,0.0000753    ,0.00002778   /,
     6 (CONV(I, 15),I=1,3)/100.0          ,44.7         ,51.44        /,
     7 (CONV(I, 16),I=1,3)/1.0            ,1.0          ,1.0          /,
     8 (CONV(I, 17),I=1,3)/0.002389       ,0.004134     ,0.002778     /,
     9 (CONV(I, 18),I=1,3)/1000.0         ,453.6        ,1000.0       /
C
     0DATA
     1 (CONV(I, 19),I=1,3)/10000.0        ,929.0304     ,10000.0      /,
     2 (CONV(I, 20),I=1,3)/1.0            ,0.01667      ,0.0002778    /,
     3 (CONV(I, 21),I=1,3)/1.0            ,1.0          ,1.0          /,
     4 (CONV(I, 22),I=1,3)/10.            ,0.01         ,0.01         /,
     5 (CONV(I, 23),I=1,3)/1.0            ,1.0          ,1.0          /,
     6 (CONV(I, 24),I=1,3)/1.0            ,1.0          ,1.0          /,
     7 (CONV(I, 25),I=1,3)/0.1            ,0.4883       ,0.1          /,
     8 (CONV(I, 26),I=1,3)/1.0            ,1.0          ,1.0          /,
```

```
      9 (CONV(I, 27),I=1,3)/1.0              ,1.0          ,0.001        /
C
      DATA
     1 (CONV(I, 28),I=1,3)/0.0002389         ,1.0          ,1.0          /,
     2 (CONV(I, 29),I=1,3)/1.0               ,1.0          ,1.0          /,
     3 (CONV(I, 30),I=1,3)/1.0               ,1.0          ,1.0          /,
     4 (CONV(I, 31),I=1,3)/1.0               ,1.0          ,1.0          /,
     5 (CONV(I, 32),I=1,3)/1.0               ,1.0          ,1.0          /,
     6 (CONV(I, 33),I=1,3)/1.0               ,1.0          ,1.0          /,
     7 (CONV(I, 34),I=1,3)/1.0               ,1.0          ,1.0          /,
     8 (CONV(I, 35),I=1,3)/1.0               ,1.0          ,1.0          /,
     9 (CONV(I, 36),I=1,3)/1.0               ,1.0          ,1.0          /
C
      DATA
     1 (CONV(I, 37),I=1,3)/1.0               ,1.0          ,1.0          /,
     2 (CONV(I, 38),I=1,3)/1.0               ,1.0          ,1.0          /,
     3 (CONV(I, 39),I=1,3)/1.0               ,1.0          ,1.0          /,
     4 (CONV(I, 40),I=1,3)/1.0               ,1.0          ,1.0          /,
     5 (CONV(I, 41),I=1,3)/1.0               ,1.0          ,1.0          /,
     6 (CONV(I, 42),I=1,3)/1.0               ,1.0          ,1.0          /,
     7 (CONV(I, 43),I=1,3)/1.0               ,1.0          ,1.0          /,
     8 (CONV(I, 44),I=1,3)/0.0075            ,51.725       ,0.00075      /,
     9 (CONV(I, 45),I=1,3)/10.0              ,68950.0      ,10000000.0   /
C
      DATA
     1 (CONV(I, 46),I=1,3)/1.0               ,1.0          ,1.0          /,
     2 (CONV(I, 47),I=1,3)/100.0             ,0.042333     ,0.001667     /
C
      DATA
     1 (UNIT(I,  1),I=1,4)/8HND        ,8HND       ,8HND       ,8HND       /,
     2 (UNIT(I,  2),I=1,4)/8HCM        ,8HM        ,8HFT       ,8HMI       /,
     3 (UNIT(I,  3),I=1,4)/8HCM3       ,8HM3       ,8HFT3      ,8HGALS     /,
     4 (UNIT(I,  4),I=1,4)/8HG/CM3     ,8HKG/M3    ,8HLB/FT3   ,8HG/CM3    /,
     5 (UNIT(I,  5),I=1,4)/8HD/CM2     ,8HN/M2     ,8HPSI      ,8HMM HG    /,
     6 (UNIT(I,  6),I=1,4)/8HC         ,8HK        ,8HF        ,8HK        /,
     7 (UNIT(I,  7),I=1,4)/8HCM2       ,8HM2       ,8HFT2      ,8HM2       /,
     8 (UNIT(I,  8),I=1,4)/8HG         ,8HKG       ,8HLB       ,8HTN       /,
     9 (UNIT(I,  9),I=1,4)/8HCL/GC     ,8HJ/KGK    ,8HBT/LBF   ,8HCL/GK    /
C
      DATA
     1 (UNIT(I, 10),I=1,4)/8HCL/G      ,8HJ/KG     ,8HBT/LB    ,8HJ/KG     /,
     2 (UNIT(I, 11),I=1,4)/8HS         ,8HS        ,8HMIN      ,8HHR       /,
     3 (UNIT(I, 12),I=1,4)/8HG/S       ,8HKG/S     ,8HLB/S     ,8HTN/HR    /,
     4 (UNIT(I, 13),I=1,4)/8HRAD       ,8HRAD      ,8HDEG      ,8HDEG      /,
     5 (UNIT(I, 14),I=1,4)/8HCL/CM2S   ,8HW/M2     ,8HBT/FT2H  ,8HKC/M2H   /,
     6 (UNIT(I, 15),I=1,4)/8HCM/S      ,8HM/S      ,8HMPH      ,8HKNOTS    /,
     7 (UNIT(I, 16),I=1,4)/8HPPM       ,8HPPM      ,8HPPM      ,8HPPM      /,
     8 (UNIT(I, 17),I=1,4)/8HCL/CMSC   ,8HW/MK     ,8HBT/FTHF  ,8HKC/MHK   /,
     9 (UNIT(I, 18),I=1,4)/8HD/CM      ,8HN/M      ,8HLB/S2    ,8HN/M      /
C
      DATA
     1 (UNIT(I, 19),I=1,4)/8HCM2/S     ,8HM2/S     ,8HFT2/S    ,8HM2/S     /,
     2 (UNIT(I, 20),I=1,4)/8H/S        ,8H/S       ,8H/MIN     ,8H/HR      /,
     3 (UNIT(I, 21),I=1,4)/8HG/HG      ,8HKG/HKG   ,8HLB/HLB   ,8HG/HG     /,
     4 (UNIT(I, 22),I=1,4)/8HDS/CM2    ,8HNS/M2    ,8HCP       ,8HCP       /,
     5 (UNIT(I, 23),I=1,4)/8HG/GM      ,8HKG/KGM   ,8HLB/LBM   ,8HKG/KGM   /,
     6 (UNIT(I, 24),I=1,4)/8HLOG FCN   ,8HLOG FCN  ,8HLOG FCN  ,8HLOG FCN  /,
     7 (UNIT(I, 25),I=1,4)/8HG/CM2S    ,8HKG/M2S   ,8HLB/FT2S  ,8HKG/M2S   /,
     8 (UNIT(I, 26),I=1,4)/8HPERCENT   ,8HPERCENT  ,8HPERCENT  ,8HPERCENT  /,
     9 (UNIT(I, 27),I=1,4)/8HG/G       ,8HKG/KG    ,8HLB/LB    ,8HG/KG     /
C
      DATA
     1 (UNIT(I, 28),I=1,4)/8HCL/GMC    ,8HJ/KGMK   ,8HBT/LBMF  ,8HCL/GMK   /,
     2 (UNIT(I, 29),I=1,4)/8HG/CM3     ,8HG/CM3    ,8HG/CM3    ,8HG/CM3    /,
     3 (UNIT(I, 30),I=1,4)/8HG/CM3C    ,8HG/CM3C   ,8HG/CM3C   ,8HG/CM3C   /,
     4 (UNIT(I, 31),I=1,4)/8HG/CM3C2   ,8HG/CM3C2  ,8HG/CM3C2  ,8HG/CM3C2  /,
     5 (UNIT(I, 32),I=1,4)/8HLN FCN    ,8HLN FCN   ,8HLN FCN   ,8HLN FCN   /,
     6 (UNIT(I, 33),I=1,4)/8HC         ,8HC        ,8HC        ,8HC        /,
     7 (UNIT(I, 34),I=1,4)/8HCL/CMSC   ,8HCL/CMSC  ,8HCL/CMSC  ,8HCL/CMSC  /,
     8 (UNIT(I, 35),I=1,4)/8HCL/CMSC2,8HCL/CMSC2,8HCL/CMSC2,8HCL/CMSC2/,
     9 (UNIT(I, 36),I=1,4)/8HCL/GC     ,8HCL/GC    ,8HCL/GC    ,8HCL/GC    /
C
```

```
      ODATA
      1 (UNIT(I, 37),I=1,4)/8HCL/GC2  ,8HCL/GC2  ,8HCL/GC2  ,8HCL/GC2  /,
      2 (UNIT(I, 38),I=1,4)/8HG/HG    ,8HG/HG    ,8HG/HG    ,8HG/HG    /,
      3 (UNIT(I, 39),I=1,4)/8HG/HGC   ,8HG/HGC   ,8HG/HGC   ,8HG/HGC   /,
      4 (UNIT(I, 40),I=1,4)/8HCL/GMC  ,8HCL/GMC  ,8HCL/GMC  ,8HCL/GMC  /,
      5 (UNIT(I, 41),I=1,4)/8HCL/GMC2 ,8HCL/GMC2 ,8HCL/GMC2 ,8HCL/GMC2 /,
      6 (UNIT(I, 42),I=1,4)/8HCL/GMC3 ,8HCL/GMC3 ,8HCL/GMC3 ,8HCL/CMC3 /,
      7 (UNIT(I, 43),I=1,4)/8HCL/GMC4 ,8HCL/GMC4 ,8HCL/GMC4 ,8HCL/GMC4 /,
      8 (UNIT(I, 44),I=1,4)/8HMM HG   ,8HN/M2    ,8HPSI     ,8HD/CM2   /,
      9 (UNIT(I, 45),I=1,4)/8HD/CM2   ,8HN/M2    ,8HPSI     ,8HMN/M2   /
C
      ODATA
      1 (UNIT(I, 46),I=1,4)/8HNA      ,8HNA      ,8HNA      ,8HNA      /,
      2 (UNIT(I, 47),I=1,4)/8HCM/S    ,8HM/S     ,8HIN/MIN  ,8HMM/MIN  /
C
C--------INITIALIZE AND SET DATA FOR OUTPUT PAGING CONTROL
C
      ODATA DTE/8H**DATE**/,LNCT/0/,LNPG/56/,LP/61/,NPG/0/,
      1     (TITLE(I),I=1,10)/10*10H          /
C
C--------SET RATE MODEL/PATH IDENTIFIERS AND FIELD SOURCE LABELS
C
      ODATA (PTLST(I),I=1,30)/
      1     4HA   ,4HB   ,4HC   ,4HD   ,4HE   ,4HF   ,4HG   ,4HH   ,
      2     4HI   ,4HJ   ,4HK   ,4HL   ,4HM   ,4HN   ,4HO   ,4HP   ,
      3     4HQ   ,4HR   ,4HS   ,4HT   ,4HU   ,4HV   ,4HW   ,4HX   ,
      4     4HY   ,4HZ   ,4HII  ,4HRR  ,4HSS  ,4H    /
C
      ODATA (SOURC(I),I=1,7)/
      1     8HMISSING ,8HDEFAULT ,8HESTIMATE,8HCHM PROP,8HCOMPUTED,
      2     8H  USER  ,8H SYSTEM /
C
C--------SPECIFY OVERLAY LOCATIONS FOR EACH RATE MODEL
C
       DATA MODNO/0/
C
C                             A  B  C  D  E  F  G  H  I  J
C                             K  L  M  N  O  P  Q  R  S  T
C                             U  V  W  X  Y  Z II RR SS
C
      ODATA (OVLST(I),I=1,29)/ 3, 4, 5, 6, 4, 7, 5, 4, 8, 5,
      1                        8, 4, 7, 5, 7, 8, 4, 8, 5, 8,
      2                        4, 8, 5, 8, 7, 7, 7, 7, 7/
C
      ODATA (SGLST(I),I=1,29)/ 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
      1                        2, 0, 0, 0, 0, 2, 0, 3, 0, 4,
      2                        0, 5, 0, 6, 0, 0, 0, 0, 0/
C
       END
       SUBROUTINE COMPG(AM,TB,PG)
C
C*******************************************************************
C
C         THIS SUBROUTINE CALCULATES THE DENSITY OF A VAPOR AT THE TEMPER
C         OF TB. THE PERFECT GAS LAW IS USED.
C
C
C *******  INPUT ARGUMENSTS  ***
C   AM        MOLECULAR WEIGHT OF THE GAS
C      TB      TEMPERATURE AT WHICH DENSITY IS DESIRED      DEGREES C
C
C***** OUTPUT ARGUMENT ****
C   PG        VAPOR DENSITY AT GIVEN TEMPERATURE            GM/CM**3
C
C*******************************************************************
C
       PG=(1.01325E6/8.314E7)*AM/(TB+273.)
C
C *** VAPOR DENSITY IS AT 1 ATM PRESSURE. RUNIV IS THE UNIVERSAL GAS
C      CONSTANT OF 8.314E7 ERG/GM-MOLE DEG K
       RETURN
       END
       SUBROUTINE ENDPR(NAME)
```

```
C
C         THIS SUBROUTINE INDICATES THE COMPLETION OF A MODELS EXECUTION
C
C        SUBROUTINES REQUIRED  - PAGER
C
      CALL PAGER(3)
      WRITE(6,100) NAME
      RETURN
  100 FORMAT(//23H THE EXECUTION OF MODEL,A4,14H IS COMPLETED.)
      END
      SUBROUTINE EPRNT(MOD,IS,IR,IFLAG)
C
C         SUBROUTINE EPRNT PRODUCES ERROR MESSAGES FOR A GIVEN MODEL
C
C        MOD     = NAME OF MODEL
C        IS      = LOWEST SOURCE CODE OBTAINED IN A SERIES OF RETRIEVALS
C                    FROM THE HACS STATE FILE
C        IR      = ERROR STATUS OF SERIES OF STATE FILE RETRIEVALS, SET
C                    TO 1 ON INPUT IF AT LEASE ONE ERROR OCCURRED
C        IFLAG   = OUTPUT INDICATOR, SET TO 0 IF MODEL IS NOT IN ERROR
C                    MODE, SET TO 1 IF ERROR RETURN IS TO BE EXECUTED
C
C        SUBROUTINES REQUIRED  - PAGER
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1  NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER UPTH
      REAL MSG
      DIMENSION STATE(2489)
      EQUIVALENCE (STATE(1),MSG(1))
      COMMON/MODCN/MODEX(29),MODIO,LOCIO
      LOGICAL ENTR, INTEGR,YESNO
      IF(LOCIO.NE.1) GO TO 2
    1 LOCIO=20
      IFLAG=2
      RETURN
    2 CONTINUE
      IFLAG=0
      IF(IS.NE.0) GO TO 10
      CALL PAGER(1)
      WRITE(6,100) MOD
      GO TO 30
   10 IF(IS.NE.1) GO TO 20
      CALL PAGER(1)
      WRITE(6,102) MOD
   20 IF(IR.NE.1) GO TO 40
      CALL PAGER(1)
      WRITE(6,101) MOD
   30 IFLAG=1
      CALL PAGER(1)
      WRITE(6,103)
      RETURN
   40 WRITE(6,104)
  104 FORMAT (40H DO YOU WISH TO CHANGE ANY MODEL INPUTS?)
      IF(YESNO(0)) GO TO 50
      LOCIO=2
      IFLAG=0
      RETURN
   50 WRITE(6,105)
  105 FORMAT (20H ENTER FIELD NUMBER:)
      GO TO 52
   51 WRITE(6,107)
  107 FORMAT (35H ENTER FIELD NUMBER OR 9999 TO EXIT)
   52 IF(.NOT.ENTR(0)) GO TO 51
      IF(.NOT.INTEGR(IFLD)) GO TO 51
      IF(IFLD.EQ.9999) GO TO 65
      NFLD=NI+NF
      DO 55 I=1,NFLD
      ILN=I
      IF(IFLD.EQ.LIST(I,1)) GO TO 60
   55 CONTINUE
      WRITE(6,106) IFLD
```

```
  106 FORMAT (14H FIELD NUMBER ,I8,14H IS UNDEFINED.)
      GO TO 51
   60 IVAR=LIST(ILN,2)/1000
      IERR=0
      ISRC=6
      LOCIO=3
      IF(IVAR.EQ.0) CALL IRCL(IFLD,IVL,ISRC,IERR)
      IF(IVAR.EQ.1) CALL FRCL(IFLD,VAL,ISRC,IERR)
      GO TO 51
   65 LOCIO=20
      IFLAG=2
      RETURN
C
  100 FORMAT(1X,45HINSUFFICIENT DATA AVAILABLE TO EXECUTE MODEL ,A4)
  101 FORMAT(1X,51HAN ERROR WAS MADE IN READING THE DATA BASE - MODEL ,
     1        A4)
  102 FORMAT(1X,16HWARNING - MODEL ,A4,24H IS USING DEFAULT VALUES)
  103 FORMAT(1X,19HEXECUTION OF MODEL ,A4,14H IS TERMINATED)
      END
          IDENT   ERR
          ENTRY   ERR
 ERR      BSSZ    1
          SB1     1
          SB2     X1+1
          EREXIT  B2
          EQ      ERR
          END
      SUBROUTINE FCHCK
C     IF AN ERROR OCCURS DURING EXECUTION, CONTROL IS TRANSFERRED
C      HERE BY COMPASS ROUTINE *ERR*.  THE TYPE OF ERROR IS
C      DETECTED AND AN INFORMATIVE MESSAGE OUTPUT.  THE PROGRAM
C      IS THEN TERMINATED.
C
C      COMMON VARIABLES USED - LP,NOV,SEG
C
C      SUBROUTINES REQUIRED - PAGER
C
C      AUTHOR - R.S. RIDGLEY, CONTROL DATA CORP.
C                             6003 EXECUTIVE BLVD.
C                             ROCKVILLE, MD. 20852
C                             (301)468-8166
C
C      DATE - 9 MARCH 1977
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
      COMMON/OVER/NOV,SEG
      DIMENSION ERRAR(12,2),ATHARR(8,2)
     0DATA (ERRAR(1,I),I=1,2)/10HTIME LIMIT,1H /,
     1      (ERRAR(2,I),I=1,2)/10HARITHMETIC,6H ERROR/,
     1      (ERRAR(3,I),I=1,2)/10HPPU ABORT ,7H- RERUN/,
     1      (ERRAR(6,I),I=1,2)/10HOP DROP-CA,10HLL CUST SV/,
     1      (ERRAR(7,I),I=1,2)/10HPROGRAM ST,2HOP/,
     1      (ERRAR(4,I),I=1,2)/10HCPU ABORT ,7H- RERUN/,
     1      (ERRAR(8,I),I=1,2)/10HFILE LIMIT,1H /,
     1      (ERRAR(9,I),I=1,2)/10HTRK LIM-CA,10HLL CUST SV/,
     1      (ERRAR(10,I),I=1,2)/10HSYS ABT-CA,10HLL CUST SV/,
     1      (ERRAR(11,I),I=1,2)/10HFORCED ERR,2HOR/,
     1      (ERRAR(12,I),I=1,2)/10HPARITY ERR,10HOR - RERUN/,
     1      (ERRAR(5,I),I=1,2)/10HPP CALL ER,9HR - RERUN/
     0DATA (ATHARR(1,I),I=1,2)/10HPROGRAM ST,2HOP/,
     1      (ATHARR(2,I),I=1,2)/10HBAD SUBSCR,3HIPT/,
     1      (ATHARR(3,I),I=1,2)/10HOVER/UNDER,5H FLOW/,
     1      (ATHARR(4,I),I=1,2)/10HBD SCRPT-D,10HVR/UND FLW/,
     1      (ATHARR(5,I),I=1,2)/10HDVD BY ZER,1HO/,
     1      (ATHARR(6,I),I=1,2)/10HBD SCRPT-D,10HVD BY ZERO/,
     1      (ATHARR(7,I),I=1,2)/10HOVR/UND FL,10HW-DVD BY 0/,
     1      (ATHARR(8,I),I=1,2)/10HUNDETERMIN,8HED ERROR/
C     FETCH RA+0 CONTINAING ERROR INFORMATION
      IRA=MEMGET(0)
C     MASK OFF ERROR FLAG IN BITS 24-29 AND RIGHT JUSTIFY
      IEF=AND(IRA,7700000000B)
      IEFL=SHIFT(IEF,-24)
```

```
C     MASK OFF ERROR MODE IN BITS 48-53 AND RIGHT JUSTIFY
      IEM=AND(IRA,77000000000000000B)
      IEMD=SHIFT(IEM,-48)
C     EXTRACT ADDRESS OF ERROR
      IADD = AND(IRA,77777700000000000B)
      IADD = SHIFT(IADD,-30)
      CALL PAGER(1)
      WRITE(LP,1000)NOV,SEG,(ERRAR(IEFL,I),I=1,2)
      IF(IEFL .EQ. 2)WRITE(LP,1001)(ATHARR(IEMD+1,I),I=1,2)
      WRITE(LP,1002)IADD,IADD
      ENDFILE 61
      ENDFILE 62
1000  FORMAT(12H IN OVERLAY ,I2,9H,SEGMENT ,I2,5H,*** ,2A10)
1001  FORMAT(31X,4H*** ,2A10)
1002  FORMAT(/* ADDRESS OF ERROR IS :(DECIMAL)- *,I7,* (OCTAL) *
     +,O10)
      STOP
      END
      SUBROUTINE FCNV(IFLD,ILN,VAL,ITYP,IS)
C
C        SUBROUTINE FCNV IS USED TO GENERATE DISPLAYS OF REAL FIELD
C        VALUES IN ALTERNATE SYSTEMS OF UNITS OF MEASURE AS PART OF
C        THE HACS DATA BASE SAVE AND RECALL FUNCTIONS.  OUTPUT PRODUCED
C        BY THIS ROUTINE IS CONTROLLED BY THE OPTION ICVSL TO DISPLAY
C        FIELD VALUES IN A SINGLE SPECIFIED SYSTEM OF UNITS, OR IN
C        ALL UNIQUE UNITS DEFINED FOR THE FIELD.
C
C
C        FAC     = ARRAY OF UNIT CONVERSION FACTORS FOR TEMPERATURES
C        I       = INDEX ON UNIT SYSTEMS FROM 1 TO MSYS
C        IFLD    = ARGUMENT, FIELD NUMBER
C        ILN     = ARGUMENT, INDEX TO FIELD NAME IN STATE FILE
C        IS      = ARGUMENT, INDEX (-1) TO SOURCE CODE LABEL
C        ITYP    = ARGUMENT, QUANTITY TYPE CORRESPONDING TO FIELD VALUE
C                     TO BE CONVERTED FOR OUTPUT DISPLAY
C        J       = INDEX RANGING FROM 1 TO I-1 USED TO DETECT DUPLICATE
C                     UNIT LABELS, ALSO INDEX FOR NAME OUTPUT
C        JJ      = INTEGER SELECTOR SET TO SYSTEM OF UNITS FOR WHICH
C                     A FULL AUDIT LINE IS PRINTED
C        TAG     = TEMPORARY STORAGE FOR UNIT LABEL IN SYSTEM I, FOR
C                     QUANTITY TYPE ITYP
C        VAL     = ARGUMENT, FIELD VALUE IN INTERNAL SYSTEM OF UNITS
C        XVAL    = FIELD VALUE CONVERTED TO UNIT SYSTEM I FOR OUTPUT
C
C        COMMON VARIABLES USED - CONV,ICVSL,LIST,LP,MSYS,NPRRP,SOURC,
C                                UNIT
C
C        SUBROUTINES REQUIRED  - PAGER
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 29 JANUARY 1976
C
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1            NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER      UPTH
      REAL         MSG
      DIMENSION    STATE(2489)
      EQUIVALENCE  (STATE(1),MSG(1))
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER      PTLST
C
```

```
C
      DIMENSION FAC(3)
      DATA       (FAC(I),I=1,3)/1.0,1.8,1.0/,FBLNK/8H
C
C
C--------SUPPRESS DISPLAY IF NPRRP SWITCH IS SET TO 0 FOR SUPPRESSING
C         AUDIT OF PROPERTY FILE ACCESS
      IF(NPRRP.EQ.0) RETURN
C
C--------INITIALIZE LOOP USING INDEX I ON SYSTEM OF UNITS SELECTED
C         OR TO FIRST SYSTEM IF ICVSL SET TO 0 FOR ALL SYSTEMS.
      I=ICVSL
      IF(I.EQ.0) I=1
C
C--------SET INDICATOR JJ TO CONTROL OUTPUT FORMAT FOR FIRST LINE AND
C         RETRIEVE LABEL TAG FOR FIRST LINE VALUE
      JJ=I
      TAG=UNIT(I,ITYP)
C
C--------CONVERT FIELD VALUE IN SYSTEM 1 (INTERNAL) TO SELECTED
C         SYSTEM FOR OUTPUT DISPLAY.  BRANCH ON TYPE OF PHYSICAL
C         QUANTITY TO SELECT CONVERSION EQUATION.
      IF(I.NE.1) GO TO 20
      XVAL=VAL
      GO TO 40
   20 IF(ITYP.EQ.6) GO TO 30
      XVAL=VAL/CONV(I-1,ITYP)
      GO TO 40
   30 XVAL=CONV(I-1,ITYP)+VAL*FAC(I-1)
C
C--------DISPLAY CONVERTED VALUE AS PART OF AUDIT OUTPUT
   40 CALL PAGER(1)
     0IF(I.EQ.JJ) WRITE(LP,1020) IFLD,(LIST(ILN,J),J=3,5),XVAL,TAG,
     1             SOURC(IS+1)
      IF(I.NE.JJ) WRITE(LP,1000) XVAL,TAG
C
C--------TEST FOR COMPLETION ON SINGLE UNIT OPTION OR ALL UNIQUE
C         UNITS DISPLAYED.
      IF(ICVSL.NE.0) GO TO 70
   50 I=I+1
      IF(I.GT.MSYS) GO TO 70
C
C--------AUDIT VALUE WHEN OPTION FOR ALL SYSTEMS SELECTED ONLY USING
C         EACH UNIQUE UNIT.  OMIT DUPLICATES.  NOTE THAT I CANNOT BE 1.
      TAG=UNIT(I,ITYP)
      J=1
   60 IF(TAG.EQ.UNIT(J,ITYP)) GO TO 50
      J=J+1
      IF(J.LT.I) GO TO 60
      GO TO 20
C
C--------INSERT SPACE BETWEEN DISPLAYS FOR DIFFERENT FIELD VALUES ON
C         OUTPUT AUDIT.
   70 CALL PAGER(1)
      WRITE(LP,1010)
      RETURN
C
 1000 FORMAT (24X,3H=  ,G13.4,2X,A8)
 1010 FORMAT (5X)
 1020 FORMAT (5X,I4,1X,3A4,5H  =  ,G13.4,2X,A8,8H, IS A  ,A8,7H  VALUE)
      END
      SUBROUTINE FRCL(IFLD,VAL,ISRC,IERR)
C
C         SUBROUTINE FRCL RECALLS THE VALUE (VAL) OF A REAL FIELD,
C         DEFINED BY THE FIELD NUMBER IFLD, FROM THE HACS STATE FILE.
C         ERROR CONDITIONS WILL PRODUCE MESSAGES, AND CAUSE VALUES OF
C         VAL=0.0, IERR=1 AND ISRC=0 TO BE RETURNED.  ARGUMENTS ISRC AND
C         IERR ARE INITIALIZED AND TESTED IN A CALLING PROGRAM TO
C         DETERMINE THE STATUS OF A GROUP OF DATA BASE RECALL OPERATIONS.
C
C
C
C         I      = INTEGER FORTRAN ARRAY INDEX
```

```
C        IERR   = ERROR CONDITION INDICATOR SET TO 1 IF ANY ERROR IS
C                    DETECTED IN PERFORMING THE REQUESTED RECALL
C        IFLD   = ARGUMENT, FIELD NUMBER FOR WHICH VALUE IS REQUESTED
C        ILN    = INDEX INTO STATE FILE TO OBTAIN DEFINITION OF FIELD
C        IS     = SOURCE CODE FOR VALUE CURRENTLY STORED IN STATE FILE
C        ISRC   = ARGUMENT, MINIMUM SOURCE CODE FOUND IN ONE OR MORE
C                    RECALL OPERATIONS GROUPED FOR INPUT TO A RATE MODEL
C        ITYP   = PRE-DEFINED TYPE OF PHYSICAL QUANTITY FOR FIELD IFLD
C        IVAR   = TYPE OF INTERNAL FIELD STORAGE FOR FIELD IFLD
C                    (0 FOR INTEGER, 1 FOR REAL)
C        IX     = INDEX STORED IN STATE FILE TO LINK FIELD DEFINITION
C                    TO FIELD VALUE ARRAYS
C        NFLD   = (NI+NF) GIVES THE TOTAL NUMBER OF FIELD DEFINITIONS
C                    ACTUALLY STORED IN THE STATE FILE
C        VAL    = ARGUMENT, RETURNED AS VALUE OF FIELD IFLD, AS RECALLED
C                    FROM THE STATE FILE IN INTERNAL UNITS, OR 0.0 IF
C                    AN ERROR WAS ENCOUNTERED.
C
C        COMMON VARIABLES USED - FVAL,LIST,LP,NF,NI
C
C        SUBROUTINES REQUIRED  - FCNV,PAGER
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 29 JANUARY 1976
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1             NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER      UPTH
      REAL         MSG
      DIMENSION    STATE(2489)
      EQUIVALENCE (STATE(1),MSG(1))
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
      COMMON/MODCN/MODEX(29),MODIO,LOCIO
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER      PTLST
C
C
C
      COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
      LOGICAL QUEST
      LOGICAL YESNO,ENTR,FLTPT,NAME
      DIMENSION FAC(3)
      DATA (FAC(I),I=1,3)/1.0,1.8,1.0/
C
C--------LOOP THROUGH ALL FIELD DEFINITIONS IN STATE FILE TO LOCATE
C        FIELD NUMBER IFLD.  NOTE THAT AT LEAST ONE FIELD (FOR CHEMICAL
C        RECOGNITION CODE) BY DEFINITION HAS BEEN PREVIOUSLY DEFINED.
C        THE VARIABLE ILN SAVES THE LOCATION IN THE STATE FILE
C        CORRESPONDING TO FIELD NUMBER IFLD, IF FOUND.
      NFLD=NI+NF
      DO 10 I=1,NFLD
      ILN=I
      IF(IFLD.EQ.LIST(I,1)) GO TO 20
   10 CONTINUE
C
C--------ERROR.  THE REQUESTED FIELD NUMBER DOES NOT EXIST IN THE HACS
C        STATE FILE.  THIS CONDITION INDICATES EITHER AN ERROR IN
C        PROGRAM CODING OF CALLS TO SUBROUTINE FRCL, OR A MISSING
C        DEFAULT FILE SPECIFICATION TO DEFINE THE FIELD BEING REQUESTED.
      CALL PAGER(2)
      WRITE(LP,1000) IFLD
      GO TO 60
C
C--------VERIFY REQUEST FOR REAL VARIABLE WITH STORAGE MODE OF VARIABLE
C        IN STATE FILE.
```

```
   20 IVAR=LIST(ILN,2)/1000
      IF(IVAR.EQ.1) GO TO 30
C
C--------ERROR.  FLOATING POINT VALUE HAS BEEN REQUESTED FOR VARIABLE
C         DEFINED IN STATE FILE AS AN INTEGER.
      CALL PAGER(2)
      WRITE(LP,1010) IFLD,(LIST(ILN,I),I=3,5)
      GO TO 60
C
C--------FIELD TYPE IS REAL, UNPACK QUANTITY TYPE AND SOURCE CODE OF
C         STORED VALUE.
   30 IS=1000*IVAR
      ITYP=(LIST(ILN,2)-IS)/10
      IS=LIST(ILN,2)-10*ITYP-IS
C
C--------UPDATE SUBROUTINE ARGUMENT TO TRACK LOWEST SOURCE CODE OF
C         FIELD VALUES RECALLED FOR USE IN EXECUTING A RATE MODEL.
C     IF(IS.LT.ISRC) ISRC=IS
C
C--------IF FIELD VALUE HAS NOT BEEN DEFINED, SET ERROR FLAG AND USE
C         0.0 FOR STANDARD AUDIT.
      IF(IS.GT.0) GO TO 40
      IERR=1
      VAL=0.0
      GO TO 50
C
C--------INDEX INTO DATA ARRAY TO RETURN VALUE OF REQUESTED FIELD
   40 IX=LIST(ILN,6)
      VAL=FVAL(IX,1)
C
C--------GENERATE HACS AUDIT DISPLAY FOR FIELD DEFINITION AND CURRENT
C         VALUES IN ALL DEFINED UNIT SYSTEMS.
   50 IF(LOCIO.NE.2) GO TO 100
C---------SECTION FOR LOCIO = 2, RECALL AND
C          DISPLAY FOR MODEL SUMMARY.
   51 CALL FCNV(IFLD,ILN,VAL,ITYP,IS)
      IF(LOCIO.NE.2) GO TO 190
C---------MIN/MAX TEST
   99 FMN=FVAL(IX,2)
      FMX=FVAL(IX,3)
      IF(VAL.LT.FMN) GO TO 260
      IF(VAL.LE.FMX) GO TO 270
  260 WRITE(LP,2040) VAL,FMN,FMX,UNIT(1,ITYP)
 20400FORMAT (25H WARNING, FIELD VALUE OF ,G13.4,11H NOT WITHIN /
     1 18H NOMINAL RANGE OF ,G13.4,4H TO ,G13.4,4H IN ,A8)
  270 CONTINUE
      GO TO 280
  100 IF(LOCIO.EQ.3) GO TO 105
      IF(IS.GT.1) GO TO 280
  1050WRITE(LP,110) (LIST(ILN,I),I=3,5),UNIT(1,ITYP),UNIT(2,ITYP),
     1  UNIT(3,ITYP),UNIT(4,ITYP)
  1100FORMAT (22H ENTER REAL VALUE FOR ,3A4,
     1  4H IN ,A8,1H,A8,1H,A8,1H,A8)
      IF(.NOT.ENTR(0)) GO TO 51
      IF(.NOT.QUEST(0)) GO TO 199
      CALL EXPLAIN(ILN)
      GO TO 105
  199 CONTINUE
      IF(.NOT.FLTPT(FVL)) GO TO 105
      ISYS=1
      IF(.NOT.NAME(TAG)) GO TO 220
  200 IF(TAG.EQ.UNIT(ISYS,ITYP)) GO TO 220
      ISYS=ISYS+1
      IF(ISYS.LE.4) GO TO 200
      WRITE(LP,2020) TAG
 2020 FORMAT (13H UNIT LABEL /,A10,12H/ IS INVALID)
      GO TO 105
  220 IF(ISYS.EQ.1) GO TO 250
      JSYS=ISYS-1
      D=CONV(JSYS,ITYP)
      IF(ITYP.NE.6) GO TO 230
      FVL=(FVL-D)/FAC(JSYS)
```

```
      GO TO 240
  230 FVL=D*FVL
  240 CONTINUE
  250 CONTINUE
C---------REPLACE STATE FILE VALUE
      FVAL(IX,1)=FVL
      VAL=FVL
      LIST(ILN,2)=LIST(ILN,2)-IS+5
      IS=5
      GO TO 99
  190 WRITE(LP,195)
  195 FORMAT (31H DO YOU WISH TO USE THIS VALUE?)
      IF(YESNO(0)) GO TO 99
      GO TO 105
  280 IF(IS.LT.ISRC) ISRC=IS
      RETURN
   60 IERR=1
      ISRC=0
      VAL=0.0
      RETURN
C
 10000FORMAT (5X,26H*****ERROR - FIELD NUMBER ,I4,42H REQUESTED FOR RECA
     1LL HAS NOT BEEN DEFINED/)
 10100FORMAT (5X,53H*****ERROR - REAL RECALL REQUESTED FOR INTEGER FIELD
     1 ,I4,1X,3A4/)
      END
      SUBROUTINE FSV(IFLD,VAL,ISRC)
C
C        SUBROUTINE FSV SAVES THE VALUE (VAL) OF A REAL FIELD, DEFINED
C        BY THE FIELD NUMBER IFLD, IN THE HACS STATE FILE DEPENDING ON
C        THE SOURCE CODE.  THE NEW VALUE IS SAVED IF ITS SOURCE CODE
C        (ISRC) IS GREATER THAN THE SOURCE CODE OF THE VALUE ALREADY
C        STORED IN THE STATE FILE.  WHETHER OR NOT THE VALUE IS SAVED,
C        THE ROUTINE PRODUCES AN OUTPUT AUDIT.
C
C
C
C        I       = INTEGER FORTRAN ARRAY INDEX
C        IFLD    = ARGUMENT, FIELD NUMBER FOR WHICH VALUE IS TO BE SAVED
C        ILN     = INDEX INTO STATE FILE TO OBTAIN DEFINITION OF FIELD
C        IS      = SOURCE CODE FOR VALUE CURRENTLY STORED IN STATE FILE
C        ISRC    = ARGUMENT, SOURCE CODE ASSOCIATED WITH VALUE OF FIELD
C                    TO BE SAVED
C        ITYP    = PRE-DEFINED TYPE OF PHYSICAL QUANTITY FOR FIELD IFLD
C        IVAR    = TYPE OF INTERNAL FIELD STORAGE FOR FIELD IFLD
C                    (0 FOR INTEGER, 1 FOR REAL)
C        IX      = INDEX STORED IN STATE FILE TO LINK FIELD DEFINITION
C                    TO FIELD VALUE ARRAYS
C        NFLD    = (NI+NF) GIVES THE TOTAL NUMBER OF FIELD DEFINITIONS
C                   ACTUALLY STORED IN THE STATE FILE
C        VAL     = ARGUMENT, GIVES VALUE OF FIELD IFLD TO BE SAVED
C
C        COMMON VARIABLES USED - FVAL,LIST,LP,NF,NI,NPRRP,SOURC,UNIT
C
C        SUBROUTINES REQUIRED  - FCNV,PAGER
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 3 FEBRUARY 1976
C
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1            NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER     UPTH
      REAL        MSG
      DIMENSION   STATE(2489)
      EQUIVALENCE (STATE(1),MSG(1))
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
```

```
C
      COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER     PTLST
C
C
C--------LOOP THROUGH ALL FIELD DEFINITIONS IN STATE FILE TO LOCATE
C         FIELD NUMBER IFLD.  NOTE THAT AT LEAST ONE FIELD (FOR CHEMICAL
C         RECOGNITION CODE) BY DEFINITION HAS BEEN PREVIOUSLY DEFINED.
C         THE VARIABLE ILN SAVES THE LOCATION IN THE STATE FILE
C         CORRESPONDING TO FIELD NUMBER IFLD, IF FOUND.
      NFLD=NI+NF
      DO 10 I=1,NFLD
      ILN=I
      IF(IFLD.EQ.LIST(I,1)) GO TO 20
   10 CONTINUE
C
C--------ERROR.  THE REQUESTED FIELD NUMBER DOES NOT EXIST IN THE HACS
C         STATE FILE.  THIS CONDITION INDICATES EITHER AN ERROR IN
C         PROGRAM CODING OF CALLS TO SUBROUTINE FRCL, OR A MISSING
C         DEFAULT FILE SPECIFICATION TO DEFINE THE FIELD BEING REQUESTED.
      CALL PAGER(2)
      WRITE(LP,1000) IFLD
      RETURN
C
C--------VERIFY REQUEST TO SAVE REAL VARIABLE WITH STORAGE MODE OF
C         VARIABLE IN STATE FILE.
   20 IVAR=LIST(ILN,2)/1000
      IF(IVAR.EQ.1) GO TO 30
C
C--------ERROR.  FLOATING POINT VALUE TO BE SAVED FOR VARIABLE STORED
C         IN STATE FILE AS AN INTEGER.
      CALL PAGER(2)
      WRITE(LP,1010) IFLD,(LIST(ILN,I),I=3,5)
      RETURN
C
C--------FIELD TYPE IS CORRECT, UNPACK CODES FROM STATE FILE.
   30 IS=1000*IVAR
      ITYP=(LIST(ILN,2)-IS)/10
      IS=LIST(ILN,2)-10*ITYP-IS
      IX=LIST(ILN,6)
C
C--------GENERATE HACS AUDIT DISPLAY FOR FIELD DEFINITION AND VALUE
C         REQUESTED TO BE SAVED.  NOTE THAT THE VALUE DISPLAYED MAY
C         NOT BE SAVED IN THE STATE FILE.
      CALL FCNV(IFLD,ILN,VAL,ITYP,ISRC)
C
C--------GENERATE WARNING MESSAGE IF VALUE TO BE SAVED EXCEEDS LIMITS.
      IF(VAL.GE.FVAL(IX,2).AND.VAL.LE.FVAL(IX,3)) GO TO 40
      IF(NPRRP.NE.0) GO TO 35
      NPRRP=1
      CALL FCNV(IFLD,ILN,VAL,ITYP,ISRC)
      NPRRP=0
   35 CONTINUE
      CALL PAGER(5)
     0WRITE(LP,1030) IFLD,(LIST(ILN,I),I=3,5),FVAL(IX,2),FVAL(IX,3),
     1                UNIT(1,ITYP)
C
C--------COMPARE SOURCE CODE OF VALUE TO BE SAVED TO SOURCE CODE OF
C         VALUE ALREADY STORED IN STATE FILE.  UPDATE ONLY IF NEW SOURCE
C         CODE EXCEEDS PREVIOUS SOURCE CODE.
   40 IF(ISRC.LT.IS) GO TO 50
      LIST(ILN,2)=LIST(ILN,2)+ISRC-IS
      FVAL(IX,1)=VAL
      RETURN
C
C--------WRITE NOTE THAT VALUE DID NOT HAVE HIGHER SOURCE CODE AND WAS
C         NOT PLACED IN THE STATE FILE.
   50 IF(NPRRP.NE.0) GO TO 55
      NPRRP=1
      CALL FCNV(IFLD,ILN,VAL,ITYP,ISRC)
```

```
      NPRRP=0
   55 CONTINUE
      CALL PAGER(3)
      WRITE(LP,1040) FVAL(IX,1),UNIT(1,ITYP),SOURC(IS+1)
      RETURN
C
 10000FORMAT (5X,26H*****ERROR - FIELD NUMBER ,I4,40H REQUESTED FOR SAVE
     1 HAS NOT BEEN DEFINED/)
 10100FORMAT (5X,51H*****ERROR - REAL SAVE REQUESTED FOR INTEGER FIELD ,
     1  I4,1X,3A4/)
 10300FORMAT (5X,30H*****WARNING - VALUE OF FIELD ,I4,1X,3A4/
     1  10X,47HREQUESTED TO BE SAVED EXCEEDS NOMINAL LIMITS OF/
     2  10X,G13.4,4H TO ,G13.4,2X,A8/10X,40HSUBSEQUENT CALCULATIONS MAY
     3NOT BE VALID/)
 10400FORMAT (5X,35H*****NOTE - VALUE IN STATE FILE OF ,G13.4,2X,A8/
     1  10X,5HIS A ,A8,27H VALUE AND WAS NOT REPLACED/)
      END
      SUBROUTINE IRCL(IFLD,IVL,ISRC,IERR)
C
C         SUBROUTINE IRCL RECALLS THE VALUE (IVL) OF AN INTEGER FIELD,
C         DEFINED BY THE FIELD NUMBER IFLD, FROM THE HACS STATE FILE.
C         ERROR CONDITIONS WILL PRODUCE MESSAGES, AND CAUSE VALUES OF
C         IVL=0, IERR=1 AND ISRC=0 TO BE RETURNED.  ARGUMENTS ISRC AND
C         IERR ARE INITIALIZED AND TESTED IN A CALLING PROGRAM TO
C         DETERMINE THE STATUS OF A GROUP OF DATA BASE RECALL OPERATIONS.
C
C
C         I      = INTEGER FORTRAN ARRAY INDEX
C         IERR   = ERROR CONDITION INDICATOR SET TO 1 IF ANY ERROR IS
C                     DETECTED IN PERFORMING THE REQUESTED RECALL
C         IFLD   = ARGUMENT, FIELD NUMBER FOR WHICH VALUE IS REQUESTED
C         ILN    = INDEX INTO STATE FILE TO OBTAIN DEFINITION OF FIELD
C         IS     = SOURCE CODE FOR VALUE CURRENTLY STORED IN STATE FILE
C         ISRC   = ARGUMENT, MINIMUM SOURCE CODE FOUND IN ONE OR MORE
C                     RECALL OPERATIONS GROUPED FOR INPUT TO A RATE MODEL
C         ITYP   = PRE-DEFINED TYPE OF PHYSICAL QUANTITY FOR FIELD IFLD
C         IVAR   = TYPE OF INTERNAL FIELD STORAGE FOR FIELD IFLD
C                   (0 FOR INTEGER, 1 FOR REAL)
C         IVL    = ARGUMENT, RETURNED AS VALUE OF FIELD IFLD, AS RECALLED
C                     FROM THE STATE FILE IN INTERNAL UNITS, OR 0 IF
C         IX     = INDEX STORED IN STATE FILE TO LINK FIELD DEFINITION
C                     TO FIELD VALUE ARRAYS
C         NFLD   = (NI+NF) GIVES THE TOTAL NUMBER OF FIELD DEFINITIONS
C                     ACTUALLY STORED IN THE STATE FILE
C
C         COMMON VARIABLES USED - IVAL,LIST,LP,NF,NI,SOURC,UNIT
C
C         SUBROUTINES REQUIRED  - PAGER
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C         DATE   - 29 JANUARY 1976
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1           NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER      UPTH
      REAL         MSG
      DIMENSION    STATE(2489)
      EQUIVALENCE (STATE(1),MSG(1))
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
      COMMON/MODCN/MODEX(29),MODIO,LOCIO
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER     PTLST
      LOGICAL YESNO,ENTR,INTEGR
      LOGICAL QUEST
C
```

```
C
C--------LOOP THROUGH ALL FIELD DEFINITIONS IN STATE FILE TO LOCATE
C         FIELD NUMBER IFLD.  NOTE THAT AT LEAST ONE FIELD (FOR CHEMICAL
C         RECOGNITION CODE) BY DEFINITION HAS BEEN PREVIOUSLY DEFINED.
C         THE VARIABLE ILN SAVES THE LOCATION IN THE STATE FILE
C         CORRESPONDING TO FIELD NUMBER IFLD, IF FOUND.
      NFLD=NI+NF
      DO 10 I=1,NFLD
      ILN=I
      IF(IFLD.EQ.LIST(I,1)) GO TO 20
   10 CONTINUE
C
C--------ERROR.  THE REQUESTED FIELD NUMBER DOES NOT EXIST IN THE HACS
C         STATE FILE.  THIS CONDITION INDICATES EITHER AN ERROR IN
C         PROGRAM CODING OF CALLS TO SUBROUTINE IRCL, OR A MISSING
C         DEFAULT FILE SPECIFICATION TO DEFINE THE FIELD BEING REQUESTED.
      CALL PAGER(2)
      WRITE(LP,1000) IFLD
      GO TO 60
C
C--------VERIFY REQUEST FOR INTEGER VARIABLE WITH STORAGE MODE OF
C         VARIABLE IN STATE FILE
   20 IVAR=LIST(ILN,2)/1000
      IF(IVAR.EQ.0) GO TO 30
C
C--------ERROR.  INTEGER VALUE HAS BEEN REQUESTED FOR VARIABLE DEFINED
C         IN STATE FILE AS A FLOATING POINT VALUE.
      CALL PAGER(2)
      WRITE(LP,1010) IFLD,(LIST(ILN,I),I=3,5)
      GO TO 60
C
C--------FIELD TYPE IS INTEGER, UNPACK QUANTITY TYPE AND SOURCE CODE OF
C         STORED VALUE.
   30 IS=1000*IVAR
      ITYP=(LIST(ILN,2)-IS)/10
      IS=LIST(ILN,2)-10*ITYP-IS
C
C--------UPDATE SUBROUTINE ARGUMENT TO TRACK LOWEST SOURCE CODE OF
C         FIELD VALUES RECALLED FOR USE IN EXECUTING A RATE MODEL.
C     IF(IS.LT.ISRC) ISRC=IS
C
C--------IF FIELD VALUE HAS NOT BEEN DEFINED, SET ERROR FLAG AND USE
C         0 FOR STANDARD AUDIT.
      IF(IS.GT.0) GO TO 40
      IERR=1
      IVL=0
      GO TO 50
C
C--------INDEX INTO DATA ARRAY TO RETURN VALUE OF REQUESTED FIELD
   40 IX=LIST(ILN,6)
      IVL=IVAL(IX,1)
C
C--------GENERATE HACS AUDIT DISPLAY FOR FIELD DEFINITION AND CURRENT
C         VALUE IN INTERNAL UNITS
   50 IF(LOCIO.NE.2) GO TO 70
C---------SECTION FOR LOCIO=2, RECALL AND
C          DISPLAY FOR MODEL SUMMARY
   51 IS=IS+1
      CALL PAGER(2)
      WRITE(LP,1020) IFLD,(LIST(ILN,I),I=3,5),IVL,UNIT(1,ITYP),SOURC(IS)
      IS=IS-1
      IF(LOCIO.NE.2) GO TO 80
C---------MIN/MAX TEST
   53 CONTINUE
      IMN=IVAL(IX,2)
      IMX=IVAL(IX,3)
      IF(IVL.LT.IMN) GO TO 54
      IF(IVL.LE.IMX) GO TO 55
   54 WRITE(LP,2030) IVL,IMN,IMX
 2030 FORMAT(24H WARNING, INPUT VALUE = ,I5/
     1  29H NOT WITHIN NOMINAL RANGE OF ,I5,
     2  4H TO ,I5)
```

```
   55 CONTINUE
   56 CONTINUE
   57 IF(IS.LT.ISRC) ISRC=IS
      RETURN
   70 IF(LOCIO.EQ.3) GO TO 71
      IF(IS.GT.1) GO TO 57
   71 CONTINUE
   72 WRITE(LP,2040) (LIST(ILN,I),I=3,5)
 2040 FORMAT (25H ENTER INTEGER VALUE FOR ,3A4)
      IF(.NOT.ENTR(0)) GO TO 51
      IF(.NOT.QUEST(0)) GO TO 99
      CALL EXPLAIN(ILN)
      GO TO 72
   99 CONTINUE
      IF(.NOT.INTEGR(IVL)) GO TO 72
      IVAL(IX,1)=IVL
      LIST(ILN,2)=LIST(ILN,2)-IS+5
      IS=5
      GO TO 53
   80 WRITE(LP,2050)
 2050 FORMAT (31H DO YOU WISH TO USE THIS VALUE?)
      IF(YESNO(0)) GO TO 53
      GO TO 72
C--------ERROR RETURN
   60 IERR=1
      ISRC=0
      IVL=0
      RETURN
C
 10000FORMAT (5X,26H*****ERROR - FIELD NUMBER ,I4,42H REQUESTED FOR RECA
     1LL HAS NOT BEEN DEFINED/)
 10100FORMAT (5X,53H*****ERROR - INTEGER RECALL REQUESTED FOR REAL FIELD
     1 ,I4,1X,3A4/)
 1020 FORMAT (5X,I4,1X,3A4,5H  =  ,I10,5X,A8,8H, IS A  ,A8,7H  VALUE/)
      END
      SUBROUTINE ISV(IFLD,IVL,ISRC)
C
C          SUBROUTINE ISV SAVES THE VALUE (IVL) OF AN INTEGER FIELD, GIVEN
C          BY THE FIELD NUMBER IFLD, IN THE HACS STATE FILE DEPENDING ON
C          THE SOURCE CODE.  THE NEW VALUE IS SAVED IF ITS SOURCE CODE
C          (ISRC) IS GREATER THAN THE SOURCE CODE OF THE VALUE ALREADY
C          STORED IN THE STATE FILE.  WHETHER OR NOT THE VALUE IS SAVED,
C          THE ROUTINE PRODUCES AN OUTPUT AUDIT.
C
C
C
C          I       = INTEGER FORTRAN ARRAY INDEX
C          IFLD    = ARGUMENT, FIELD NUMBER FOR WHICH VALUE IS TO BE SAVED
C          ILN     = INDEX INTO STATE FILE TO OBTAIN DEFINITION OF FIELD
C          IS      = SOURCE CODE FOR VALUE CURRENTLY STORED IN STATE FILE
C          ISRC    = ARGUMENT, SOURCE CODE ASSOCIATED WITH VALUE OF FIELD
C                       TO BE SAVED
C          ITYP    = PRE-DEFINED TYPE OF PHYSICAL QUANTITY FOR FIELD IFLD
C          IVAR    = TYPE OF INTERNAL FIELD STORAGE FOR FIELD IFLD
C                       (0 FOR INTEGER, 1 FOR REAL)
C          IVL     = ARGUMENT, GIVES VALUE OF FIELD IFLD TO BE SAVED
C          IX      = INDEX STORED IN STATE FILE TO LINK FIELD DEFINITION
C                       TO FIELD VALUE ARRAYS
C          NFLD    = (NI+NF) GIVES THE TOTAL NUMBER OF FIELD DEFINITIONS
C                       ACTUALLY STORED IN THE STATE FILE
C
C          COMMON VARIABLES USED - IVAL,LIST,LP,NF,NI,SOURC,UNIT
C
C          SUBROUTINES REQUIRED  - PAGER
C
C          AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                               35/309A ACORN PARK,
C                               CAMBRIDGE, MASS., 02140
C                               TEL. 617-864-5770  EXT. 2813
C          DATE   - 3 FEBRUARY 1976
C
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
```

```
     1             NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER      UPTH
      REAL         MSG
      DIMENSION    STATE(2489)
      EQUIVALENCE (STATE(1),MSG(1))
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER      PTLST
C
C
C--------LOOP THROUGH ALL FIELD DEFINITIONS IN STATE FILE TO LOCATE
C          FIELD NUMBER IFLD.  NOTE THAT AT LEAST ONE FIELD (FOR CHEMICAL
C          RECOGNITION CODE) BY DEFINITION HAS BEEN PREVIOUSLY DEFINED.
C          THE VARIABLE ILN SAVES THE LOCATION IN THE STATE FILE
C          CORRESPONDING TO FIELD NUMBER IFLD, IF FOUND.
      NFLD=NI+NF
      DO 10 I=1,NFLD
      ILN=I
      IF(IFLD.EQ.LIST(I,1)) GO TO 20
   10 CONTINUE
C
C--------ERROR.  THE REQUESTED FIELD NUMBER DOES NOT EXIST IN THE HACS
C          STATE FILE.  THIS CONDITION INDICATES EITHER AN ERROR IN
C          PROGRAM CODING OF CALLS TO SUBROUTINE ISV, OR A MISSING
C          DEFAULT FILE SPECIFICATION TO DEFINE THE FIELD BEING REQUESTED.
      CALL PAGER(2)
      WRITE(LP,1000) IFLD
      RETURN
C
C--------VERIFY REQUEST TO SAVE INTEGER VARIABLE WITH STORAGE MODE OF
C          VARIABLE IN STATE FILE.
   20 IVAR=LIST(ILN,2)/1000
      IF(IVAR.EQ.0) GO TO 30
C
C--------ERROR.  INTEGER VALUE TO BE SAVED FOR VARIABLE STORED IN
C          STATE FILE AS A REAL VARIABLE.
      CALL PAGER(2)
      WRITE(LP,1010) IFLD,(LIST(ILN,I),I=3,5)
 10100FORMAT (5X,51H*****ERROR - INTEGER SAVE REQUESTED FOR REAL FIELD ,
     1  I4,1X,3A4/)
      RETURN
C
C--------FIELD TYPE IS CORRECT, UNPACK CODES FROM STATE FILE.
   30 IS=1000*IVAR
      ITYP=(LIST(ILN,2)-IS)/10
      IS=LIST(ILN,2)-10*ITYP-IS
      IX=LIST(ILN,6)
C
C--------GENERATE HACS AUDIT DISPLAY FOR FIELD DEFINITION AND VALUE
C          REQUESTED TO BE SAVED.  NOTE THAT THE VALUE DISPLAYED MAY
C          NOT BE SAVED IN THE STATE FILE.
      CALL PAGER(2)
     0WRITE(LP,1020) IFLD,(LIST(ILN,I),I=3,5),IVL,UNIT(1,ITYP),
     1    SOURC(ISRC+1)
C
C--------GENERATE WARNING MESSAGE IF VALUE TO BE SAVED EXCEEDS LIMITS.
      IF(IVL.GE.IVAL(IX,2).AND.IVL.LE.IVAL(IX,3)) GO TO 40
      CALL PAGER(5)
     0WRITE(LP,1030) IFLD,(LIST(ILN,I),I=3,5),IVAL(IX,2),IVAL(IX,3),
     1                UNIT(1,ITYP)
C
C--------COMPARE SOURCE CODE OF VALUE TO BE SAVED TO SOURCE CODE OF
C          VALUE ALREADY STORED IN STATE FILE.  UPDATE ONLY IF NEW SOURCE
C          CODE EXCEEDS PREVIOUS SOURCE CODE.
   40 IF(ISRC.LT.IS) GO TO 50
      LIST(ILN,2)=LIST(ILN,2)+ISRC-IS
      IVAL(IX,1)=IVL
      RETURN
```

```
C
C--------WRITE NOTE THAT VALUE DID NOT HAVE HIGHER SOURCE CODE AND WAS
C        NOT PLACED IN THE STATE FILE.
   50 CALL PAGER(3)
      WRITE(LP,1040) IVAL(IX,1),UNIT(1,ITYP),SOURC(IS+1)
      RETURN
C
 10000FORMAT (5X,26H*****ERROR - FIELD NUMBER ,I4,40H REQUESTED FOR SAVE
     1 HAS NOT BEEN DEFINED/)
 1020 FORMAT (5X,I4,1X,3A4,5H  =  ,I10,5X,A8,8H, IS A  ,A8,7H  VALUE/)
 10300FORMAT (5X,30H*****WARNING - VALUE OF FIELD ,I4,1X,3A4/
     1  10X,47HREQUESTED TO BE SAVED EXCEEDS NOMINAL LIMITS OF/
     2  10X,I10,3X,4H TO ,I10,5X,A8/10X,40HSUBSEQUENT CALCULATIONS MAY N
     3OT BE VALID/)
 10400FORMAT (5X,35H*****NOTE - VALUE IN STATE FILE OF ,I10,5X,A8/
     1  10X,5HIS A ,A8,27H VALUE AND WAS NOT REPLACED/)
      END
      SUBROUTINE LABEL(X,ND,SCALE,NDIV)
C
C         SUBROUTINE LABEL COMPUTES AN ARRAY OF AXIS LABELS, SCALE, TO
C         BE USED IN PLOTTING VALUES OF THE VARIABLE X ALONG A SCALE
C         DIVIDED INTO NDIV INTERVALS.  THE NUMBER OF DATA POINTS IN
C         THE ARRAY X IS GIVEN BY ND. THE DIMENSION OF THE ARRAY SCALE
C         MUST BE SET IN THE CALLING PROGRAM AS NDIV+1 OR GREATER.
C         SUBROUTINE LABEL ASSUMES THAT ND IS GIVEN ON INPUT AS 2
C         OR GREATER.  IF ND IS LESS THAN 2, ERRONEOUS RESULTS WILL
C         BE RETURNED.
C
C         THE ROUTINE EMPLOYS A ROUNDING TECHNIQUE USED BY K.M. WIIG
C         AT ADL TO PRODUCE SMOOTH AXIS LABELS BASED SOLELY ON THE
C         RANGE OF THE DATA TO BE PLOTTED, NOT PRE-DEFINED INTERVAL
C         SIZES.  THE RANGE OF THE PLOT SCALE PRODUCED IS ALWAYS EQUAL
C         TO OR GREATER THAN THE RANGE OF DATA VALUES X.
C
C         SEVERAL PARAMETERS ARE USED AND VALUES ARE PRE-SET IN DATA
C         STATEMENTS TO SIMPLIFY ANY ADJUSTMENTS WHICH MAY BE DESIRED.
C         IN PARTICULAR, THE PARAMETER FAC REPRESENTS A LIMITING RATIO
C         OF THE MINIMUM VALUE OF X TO THE MAXIMUM VALUE.  IF ALL X ARE
C         POSITIVE, BUT XMIN IS LESS THAN FAC*XMAX, THE ORIGIN WILL
C         AUTOMATICALLY BE INCLUDED IN THE PLOT SCALE.
C
C
C         D       = GIVES THE NOMINAL RANGE OF THE PLOT SCALE (XMAX-XMIN)
C         FAC     = MAXIMUM PROPORTION OF PLOT SCALE ALLOCATED TO INCLUDE
C                      THE ORIGIN IF ALL X ARE POSITIVE
C         I       = INTEGER LOOP INDEX, INTEGER VARIABLE FOR ROUNDING
C                      OPERATION, AND MULTIPLE OF PROPORTIONAL SPACING
C         IRND    = ARRAY OF DESIRED PROPORTIONAL SPACING MULTIPLES, WITH
C                      DATA VALUES SET SUCH THAT IRND(I) IS GREATER THAN
C                      OR EQUAL TO I FOR I LESS THAN OR EQUAL TO 20.
C         J       = INTEGER LOOP INDEX OVER NUMBER OF INTERVALS NDIV
C         K       = DUMMY SUBSCRIPT (=J+1) FOR INDEXING OUTPUT SCALE
C                      FROM 2 TO NDIV+1
C         LOGDEL  = INTEGER PART OF COMMON LOGARITHM
C         ND      = ARGUMENT, NUMBER OF DATA POINTS GIVEN IN THE ARRAY X
C                     (VALUE GIVEN ON INPUT MUST BE 2 OR GREATER)
C         NDIV    = ARGUMENT, NUMBER OF DIVISIONS OF PLOT SCALE FOR WHICH
C                      LABELS ARE DESIRED.
C         RLIMA   = LIMIT VALUE USED TO CORRECT SMALL NUMBER ERROR
C         RLIMB   = LIMIT VALUE USED TO CORRECT SMALL NUMBER ERROR
C         RND     = VARIABLE ROUND-OFF FACTOR
C         SCALE   = ARGUMENT, OUTPUT VALUES ARE DESIRED AXIS LABELS FROM
C                      1 TO NDIV+1
C         TENN    = TEN RAISED TO THE NTH POWER
C         TENN1   = TEN RAISED TO THE (N-1) POWER
C         TOL     = SET TOLERANCE USED TO CANCEL ROUND-OFF IF VALUE IS
C                      VERY CLOSE TO, BUT ON WRONG SIDE, OF INTEGER VALUE
C         X       = ARGUMENT, ARRAY OF N DATA POINTS
C         XMAX    = MAXIMUM VALUE OF DATA POINTS X(I)
C         XMIN    = MINIMUM VALUE OF DATA POINTS X(I), AND ADJUSTED
C                      LOWER LIMIT OF PLOT SCALE
C
```

```
C        COMMON VARIABLES USED - NONE
C
C        SUBROUTINES REQUIRED  - ABS,ALOG10,FLOAT
C
C        AUTHORS- K.M. WIIG,  ARTHUR D. LITTLE, INC.,
C                 R.G. POTTS  35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 16 OCTOBER 1975
C
C
      DIMENSION IRND(20),SCALE(1),X(1)
     0DATA       (IRND(I),I=1,20)/1,2,3,4,5,6,8,8,10,10,12,12,15,15,15,
     1                          20,20,20,20,20/
      DATA       FAC/0.20/,RLIMA/0.000000001/,RLIMB/0.00000000001/
      DATA       TOL/0.00001/
C
C
C--------SEARCH DATA ARRAY TO OBTAIN UPPER AND LOWER BOUNDS
      XMIN=X(1)
      XMAX=X(1)
      DO 10 I=2,ND
      IF(XMIN.GT.X(I)) XMIN=X(I)
      IF(XMAX.LT.X(I)) XMAX=X(I)
   10 CONTINUE
C
C--------TEST FOR INCLUSION OF ORIGIN.  IF SO, SET XMIN=0, AND JUMP
C        TO COMPUTE AXIS LABELS.  OTHERWISE SET UP ROUND-OFF FACTORS
C        FOR XMIN.
      IF(XMIN) 30,60,20
   20 IF(XMIN.GE.FAC*XMAX) GO TO 40
      XMIN=0.0
      GO TO 60
   30 RND=TOL-1.0
      GO TO 50
   40 RND=TOL
C
C--------COMPUTE LOWER BOUND OF PLOT SCALE.  OBTAIN NOMINAL RANGE D,
C        RESET IF SMALL NUMBER ERROR OCCURS.
   50 D=XMAX-XMIN
      IF(D.LE.0.0) D=RLIMA
C--------OBTAIN INTEGER PART OF COMMON LOGARITHM, AND COMPUTE 10**N-1.
      LOGDEL=ALOG10(D)
      TENN=10.**LOGDEL
      TENN1=TENN/10.
C--------ROUND-OFF LOWER LIMIT FOR PLOT SCALE
      XMIN=XMIN/TENN1
      I=XMIN+RND
      XMIN=I*TENN1
C
C--------COMPUTE RANGE OF PLOT SCALE.  GET NOMINAL RANGE AND ADJUST
C        FOR VERY SMALL VALUES
   60 D=ABS(XMAX-XMIN)
      IF(D.LE.0.0) D=RLIMB
C--------OBTAIN INTEGER PART OF COMMON LOGARITHM, ADJUST IF D IS LESS
C        THAN 1.0, AND COMPUTE 10**N
      LOGDEL=ALOG10(D)
      IF(D.LT.1.0) LOGDEL=LOGDEL-1
      TENN=10.**LOGDEL
C--------COMPUTE MULTIPLE FOR DESIRED RANGE FACTOR
      I=(20./FLOAT(NDIV))*(D/TENN)+1.0-TOL
C--------REMOVE COMMENT ON STATEMENT BELOW TO USE ARRAY IRND TO
C        ELIMINATE UNDESIRABLE MULTIPLES OF I
C     IF(I.LT.20) I=IRND(I)
C
C--------COMPUTE COORDINATES FOR PLOT AXIS LABELING.
      SCALE(1)=XMIN
      TENN=FLOAT(I)*TENN/20.
      DO 70 J=1,NDIV
      K=J+1
   70 SCALE(K)=XMIN+TENN*FLOAT(J)
      RETURN
```

```
C
      END
      SUBROUTINE LINK
C
C        SUBROUTINE LINK IS A DUMMY ROUTINE LOCATED IN THE ROOT OVER-
C        LAY WITH REFERENCES TO COMMONLY USED EXTERNAL LIBRARY
C        FUNCTIONS.  THESE REFERENCES FORCE THE LOADING OF THESE
C        ROUTINES WITH THE MAIN OVERLAY INSTEAD OF MULTIPLE OCCURRENCES
C        OF EACH ROUTINE IN INDIVIDUAL CALLING OVERLAYS.  THE PARAMETERS
C        A, B AND I ARE DUMMIES USED TO ESTABLISH FUNCTION REFERENCES.
C
C        COMMON VARIABLES USED - NONE
C
C        SUBROUTINES REQUIRED  - (REFER TO PROGRAM CODE FOLLOWING)
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 16 OCTOBER 1975
C
      B=10.
      I=10
      A=ABS(B)
      A=ALOG(B)
      A=ALOG10(B)
      A=ATAN(B)
      A=COS(B)
      A=EXP(B)
      A=FLOAT(I)
      A=SQRT(B)
      RETURN
      END
      SUBROUTINE LSTFL(ISW)
C
C        SUBROUTINE LSTFL (FOR LIST FILE) EXECUTES THE USER SELECTED
C        OPTION, IF ANY, TO DISPLAY THE CONTENTS OF THE HACS STATE
C        FILE AT A TIME CORRESPONDING TO THE ARGUMENT ISW -
C
C              ISW  =  1   DISPLAY FILE CONTENTS AFTER INITIALIZATION
C              ISW  =  2   DISPLAY FILE CONTENTS AFTER USER INPUT
C              ISW  =  3   DISPLAY FILE CONTENTS AFTER ASSESSMENT RUN
C
C        THE ROUTINE OBTAINS FILE OUTPUT OPTIONS FROM THE ARRAY LSTCN
C        WHOSE CONTENTS ARE DETERMINED BY USER CONTROL INPUT.  OUTPUT
C        IS SUPPRESSED IF THE OPTION HAS NOT BEEN SELECTED, OR IF THE
C        STATE FILE IS UNDEFINED OR EMPTY.  SUBROUTINE LSTFL PERFORMS
C        AN OUTPUT FUNCTION ONLY, NO COMPUTED VALUES ARE RETURNED TO
C        THE CALLING PROGRAM.
C
C
C
C        A       = FLOATING POINT VALUE OF FIELD RETRIEVED FROM STATE
C                    FILE, AND VALUE CONVERTED FOR OUTPUT
C        B       = FLOATING POINT MINIMUM VALUE OF FIELD RETRIEVED FROM
C                    STATE FILE, AND VALUE CONVERTED FOR OUTPUT
C        C       = FLOATING POINT MAXIMUM VALUE OF FIELD RETRIEVED FROM
C                    STATE FILE, AND VALUE CONVERTED FOR OUTPUT
C        CP      = FORTRAN INTEGER UNIT NUMBER FOR CARD PUNCH
C        D       = FIELD CONVERSION FACTOR FOR GIVEN QUANTITY TYPE AND
C                    REQUESTED OUTPUT SYSTEM
C        FAC     = ARRAY OF UNIT CONVERSION FACTORS FOR TEMPERATURES
C        I       = DUMMY INDEX, AND LOOP THROUGH FIELDS DEFINED IN STATE
C                    FILE
C        IFLD    = FIELD NUMBER RETRIEVED FROM STATE FILE
C        IN      = ARRAY OF OUTPUT LABELS TO IDENTIFY OPERATION PRECEDING
C                    OUTPUT DISPLAY
C        IPN     = CARD PUNCH OUTPUT OPTION COPIED FROM ARRAY LSTCN
C                    (0 TO SUPPRESS, 1 TO SELECT)
C        ISRC    = FIELD VALUE SOURCE CODE (0 TO 6) RETRIEVED FROM
C                    STATE FILE
C        ISW     = ARGUMENT, INDEXES CONTENTS OF LSTCN TO OBTAIN OPTIONS
C                    SELECTED, IF ANY, FOR DISPLAY AT POINTS GIVEN ABOVE
```

```
C                    FOR ISW = 1, 2, OR 3
C          ISYS    = OPTION SELECTED BY USER FOR OUTPUT SYSTEM OF UNITS
C                    (VALUES ARE 0=1, 2, 3, 4)
C          ITYP    = FIELD QUANTITY TYPE RETRIEVED FROM STATE FILE
C          IVAR    = FIELD STORAGE TYPE RETRIEVED FROM STATE FILE
C                    (0 = INTEGER, 1 = REAL)
C          IX      = INDEX RETRIEVED FROM STATE FILE, POINTS TO ARRAY
C                    LOCATIONS GIVING FIELD VALUES
C          J       = DUMMY ARRAY INDEX
C          JSRC    = HAS VALUE OF ISRC+1, IN RANGE 1 TO 7, TO INDEX DATA
C                    ARRAY OF OUTPUT LABELS.
C          JSYS    = HAS VALUE OF ISYS-1 TO INDEX ARRAY OF CONVERSION
C                    FACTORS.  SYSTEM 1 GIVES INTERNAL UNITS, AND
C                    CONVERSION FACTORS ARE NOT STORED.
C          NFLD    = TOTAL NUMBER OF FIELDS DEFINED IN STATE FILE.
C          TAG     = TEMPORARY STORAGE OF FIELD UNIT OUTPUT LABEL
C
C          COMMON VARIABLES USED - CONV,FVAL,IVAL,LBL,LIST,LP,LSTCN,
C                                  MSG,NF,NI,SOURC,STCON,UNIT
C
C          SUBROUTINES REQUIRED  - PAGER
C
C          AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                               35/309A ACORN PARK,
C                               CAMBRIDGE, MASS., 02140
C                               TEL. 617-864-5770  EXT. 2813
C          DATE   - 22 JANUARY 1976
C
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1            NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER     UPTH
      REAL        MSG
C
     0COMMON/CNTRL/EOFF,ICD,IDFLT,LBL(4),LSTCN(3,3),MODEL(15),NOP,
     1             STCON,SVCON
      INTEGER      EOFF,STCON,SVCON
      REAL         LBL
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER     PTLST
C
C
      INTEGER   CP
      DIMENSION FAC(3),IN(3,4)
      DATA      CP/62/
      DATA      (FAC(I),I=1,3)/1.0,1.8,1.0/
      DATA      (IN(1,I),I=1,4)/4HINIT,4HIALI,4HZATI,4HON   /
      DATA      (IN(2,I),I=1,4)/4HUSER,4H INP,4HUT   ,4H    /
      DATA      (IN(3,I),I=1,4)/4HASSE,4HSSME,4HNT R,4HUN   /
C
C
C--------TEST FOR REQUESTED LIST OPTION AND RETURN IF NOT SELECTED
      IF(LSTCN(ISW,1).EQ.0) RETURN
C
C--------WRITE HEADER FOR OPTION SELECTED AND FILE TYPE
      IF(ISW.NE.1) CALL PAGER(0)
      CALL PAGER(3)
      WRITE(LP,1000) (IN(ISW,I),I=1,4)
      CALL PAGER(1)
      WRITE(LP,1010) LBL(STCON)
C
C--------IF STATE FILE IS UNDEFINED OR EMPTY, SKIP OUTPUT WITH MESSAGE
C          AND RETURN
      IF(STCON.LE.1) GO TO 10
      NFLD=NF+NI
      IF(NFLD.GT.1) GO TO 20
   10 CALL PAGER(3)
```

```
      WRITE(LP,1020)
      RETURN
C
C--------RETRIEVE FILE DISPLAY OPTIONS, OVERRIDE DEFAULT FOR UNIT
C           SELECTION
   20 ISYS=LSTCN(ISW,2)
      IF(ISYS.EQ.0) ISYS=1
      JSYS=ISYS-1
      IPN=LSTCN(ISW,3)
C
C--------WRITE STATE FILE HEADER
      CALL PAGER(2)
      WRITE(LP,1030) MSG
      IF(IPN.EQ.1) WRITE(CP,1040) MSG
      CALL PAGER(3)
      WRITE(LP,1050)
      CALL PAGER(3)
      WRITE(LP,1060)
C
C--------LOOP ON NUMBER OF FIELDS DEFINED IN FILE
      DO 60 I=1,NFLD
C
C--------UNCODE DATA FROM STATE FILE FOR FIELD IN LIST POSITION I
      IFLD=LIST(I,1)
      IVAR=LIST(I,2)/1000
      ISRC=1000*IVAR
      ITYP=(LIST(I,2)-ISRC)/10
      ISRC=LIST(I,2)-10*ITYP-ISRC
      JSRC=ISRC+1
      IX=LIST(I,6)
      TAG=UNIT(ISYS,ITYP)
C
C--------IF FIELD IS REAL, APPLY OUTPUT CONVERSION AND DISPLAY
      IF(IVAR.EQ.0) GO TO 40
      A=FVAL(IX,1)
      B=FVAL(IX,2)
      C=FVAL(IX,3)
      IF(JSYS.LE.0) GO TO 30
      D=CONV(JSYS,ITYP)
C--------BRANCH FOR TEMPERATURE CONVERSION EQUATION
      IF(ITYP.EQ.6) GO TO 25
      A=A/D
      B=B/D
      C=C/D
      GO TO 30
   25 A=D+A*FAC(JSYS)
      B=D+B*FAC(JSYS)
      C=D+C*FAC(JSYS)
   30 CALL PAGER(1)
     0WRITE(LP,1070) IFLD,A,TAG,IVAR,ISRC,SOURC(JSRC),B,C,
     1     ITYP,(LIST(I,J),J=3,5)
     0IF(IPN.EQ.1) WRITE(CP,1080) IFLD,A,TAG,IVAR,B,C,
     1     ITYP,(LIST(I,J),J=3,5)
      GO TO 60
C
C--------FOR INTEGER FIELDS, DISPLAY ALL FIELDS IN SAME FORMAT EXCEPT
C           FOR FIELD 1001, CHEMICAL RECOGNITION CODE
   40 IF(IFLD.NE.1001) GO TO 50
      CALL PAGER(1)
     0WRITE(LP,1090) IFLD,IVAL(IX,1),TAG,IVAR,ISRC,
     1     SOURC(JSRC),ITYP,(LIST(I,J),J=3,5)
      IF(IPN.EQ.1) WRITE(CP,1100) IFLD,IVAL(IX,1),TAG
      GO TO 60
C
   50 CALL PAGER(1)
     0WRITE(LP,1110) IFLD,IVAL(IX,1),TAG,IVAR,ISRC,
     1     SOURC(JSRC),IVAL(IX,2),IVAL(IX,3),ITYP,(LIST(I,J),J=3,5)
     0IF(IPN.EQ.1) WRITE(CP,1120) IFLD,IVAL(IX,1),TAG,IVAR,
     1     IVAL(IX,2),IVAL(IX,3),ITYP,(LIST(I,J),J=3,5)
C
   60 CONTINUE
C
```

```
C--------WRITE MESSAGE IF CARD DECK WAS PUNCHED
      CALL PAGER(3)
      IF(IPN.EQ.1) WRITE(LP,1130)
      IF(ISW.EQ.1) CALL PAGER(0)
      RETURN
C
 10000FORMAT (//5X,49HOPTION SELECTED TO DISPLAY HACS STATE FILE AFTER ,
     1  4A4)
 1010 FORMAT (10X,14HFILE CONTAINS ,A8,7H VALUES)
 10200FORMAT (10X,52HSTATE FILE IS UNDEFINED - OUTPUT HAS BEEN SUPPRESSE
     1D//)
 1030 FORMAT (10X,20HFILE LABEL FOLLOWS -/20X,10A8)
 1040 FORMAT (10A8)
 1050 FORMAT (10X,22HFILE LISTING FOLLOWS -//)
 10600FORMAT (10X,5HFIELD,30X,19HO=INTEGER    SOURCE,38X,7HTYPE OF/10X,
     1 41HNUMBER     FIELD VALUE       UNIT     1=REAL,8X,4HCODE,5X,
     2 55HNOMINAL MINIMUM  NOMINAL MAXIMUM  QUANTITY   FIELD NAME/
     3 10X,6(1H-),2X,15(1H-),2X,8(1H-),2X,9(1H-),2X,10(1H-),2X,15(1H-),
     4 2X,15(1H-),2X,8(1H-),2X,12(1H-))
 10700FORMAT (11X,I4,3X,G15.4,2X,A8,2(6X,I1),1H=,A8,2(2X,G15.4),5X,
     1     I2,5X,3A4)
 1080 FORMAT (I4,G15.4,A8,I1,1H3,2G15.4,I2,3A4)
 10900FORMAT (11X,I4,3X,A4,13X,A8,2(6X,I1),1H=,A8,2(2X,3HN/A,12X),5X,
     1     I2,5X,3A4)
 1100 FORMAT (I4,A4,11X,A8)
 11100FORMAT (11X,I4,8X,I10,2X,A8,2(6X,I1),1H=,A8,2(7X,I10),5X,I2,
     1      5X,3A4)
 1120 FORMAT (I4,5X,I10,A8,I1,1H3,2(5X,I10),I2,3A4)
 1130 FORMAT (//10X,34HSTATE FILE DATA CARDS WERE PUNCHED)
      END
      SUBROUTINE OUTPR(NAME)
C
C         THIS SUBROUTINE PRINTS A MESSAGE TO INDICATE THAT THE OUTPUT
C         FROM A RATE MODEL FOLLOWS.
C
C         SUBROUTINES REQUIRED  - PAGER
C
      CALL PAGER(5)
      WRITE(6,100) NAME
      RETURN
  100 FORMAT(//21H THE RESULTS OF MODEL,A4, 7H ARE...//)
      END
      SUBROUTINE OVLOD(NOV)
C
C         INTERFACE ROUTINE TO OVERLAY LOAD FUNCTION WHERE NOV GIVES
C         THE NUMBER OF THE OVERLAY TO BE LOADED.  ALL CALLS TO THE
C         OVERLAY LOAD FUNCTION ARE LOCATED IN THE HACS MAIN PROGRAM
C         WHICH ITSELF IS PART OF OVERLAY 0.  NOTE THAT SINCE OVERLAY
C         0 IS RESIDENT THROUGHOUT EACH EXECUTION, A CALL OVLOD(0) HAS
C         BEEN DISABLED.  OVERLAY SELECTION IS BASED ON THE USE OF A
C         DATA ARRAY OVLST WHICH IS INDEXED BY THE INTEGER RATE MODEL
C         EQUIVALENT MODNO.  OVERLAY ALLOCATION TO RATE MODELS IS
C         DETERMINED BY THE LOCATION OF PROGRAM CODE AND DATA ELEMENTS
C         OF OVLST.  PRE-DEFINED OVERLAY ALLOCATIONS ARE AS FOLLOWS -
C                   0  =  MAIN HACS CONTROL PROGRAM AND ALL FREQUENTLY
C                               USED GENERAL PURPOSE HACS AND SYSTEM
C                               LIBRARY ROUTINES
C                   1  =  HACS INPUT DATA PROCESSOR
C                   2  =  NOT USED (FORMERLY ALLOCATED TO HACS X-Y
C                               GRAPHIC OUTPUT PROCESSOR)
C
C         COMMON VARIABLES USED - NONE
C
C         SUBROUTINES REQUIRED  - UFOVER
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C         DATE   - 16 OCTOBER 1975
C
      IF(NOV.LE.0) RETURN
```

```
      CALL OVERLAY(6HUIMABS,NOV,0,6HRECALL)
      RETURN
      END
      SUBROUTINE PAGER(LINES)
C
C         SUBROUTINE COMPARES THE NUMBER OF OUTPUT LINES TO BE WRITTEN
C         ON UNIT LP, SPECIFIED BY THE ARGUMENT LINES, TO THE NUMBER OF
C         LINES REMAINING ON THE PAGE, LNPG-LNCT, AND WRITES A HEADER
C         AT THE TOP OF A NEW PAGE WHEN INSUFFICIENT SPACE IS LEFT TO
C         WRITE A BLOCK OF LENGTH LINES. A NEW PAGE MAY BE FORCED BY
C         CALLING THE ROUTINE WITH LINES SET TO ZFRO AS THE ARGUMENT.
C         THE HEADER LINE PRODUCED CONSISTS OF AN 80 CHARACTER TITLE,
C         DATE AND PAGE NUMBER. THE PAGE NUMBER IS AUTOMATICALLY
C         UPDATED BY THIS ROUTINE.
C
C
C         LINES  = NUMBER OF OUTPUT LINES TO BE WRITTEN IMMEDIATELY
C                   FOLLOWING CALL TO PAGER
C         TIME   = TIME OF DAY OBTAINED FROM SYSTEM LIBRARY MACRO AS
C                   24-HOUR CLOCK READING IN A8 FORMAT AS HH/MM/SS
C
C         COMMON VARIABLES USED - DATE,LNCT,LNPG,LP,NPG,TITLE
C
C         SUBROUTINE REQUIRED  - TMDY
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                              35/309A ACORN PARK,
C                              CAMBRIDGE, MASS., 02140
C                              TEL. 617-864-5770  EXT. 2813
C         DATE   - 27 MAY 1975
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
C
C--------TEST FOR TOP OF FORM COMMAND, I.E., CALL PAGER(0)
      IF(LINES.EQ.0) GO TO 10
C--------INCREMENT CUMULATIVE LINE COUNT WITH NUMBER OF LINES TO BE
C         WRITTEN FOLLOWING CALL AND COMPARE TO PAGE LIMIT.  RETURN IF
C         LESS THAN LIMIT.
      LNCT=LNCT+LINES
      IF(LNCT.LE.LNPG) RETURN
C--------PAGE LIMIT REACHED OR EXCEEDED.  INCREMENT PAGE COUNTER, WRITE
C         HEADER AND SET LINE COUNT TO NUMBER OF LINES IN HEADER PLUS
C         OUTPUT LINES FOLLOWING.
   10 NPG=NPG+1
      CALL TIME(TIM)
C     WRITE(LP,1000) DTE,TIM,NPG,TITLE
      LNCT=LINES+6
      RETURN
C
 10000FORMAT (46H1HAZARD ASSESSMENT COMPUTER SYSTEM (HACS) DATE,A10,
     1         1X,4HTIME,A9,2X,4HPAGE,I3//1X,9A8,A7/1X,79(1H*)//)
      END
      SUBROUTINE PLTLP(PTITL,X,Y,N,XTITL,YTITL,II,DIV,XTITL1)
C
C         SUBROUTINE PLTLP PRODUCES A ONE PAGE 40 BY 80 LINE PRINTER
C         PLOT OF THE DATA POINTS (X(J),Y(J)), J=1,N.  THE ARGUMENTS
C         TO THE ROUTINE PROVIDE FOR A PLOT TITLE, IDENTIFICATION ALONG
C         EACH AXIS AND AN OPTION TO PRODUCE A DOUBLE SET OF LABELS
C         FOR THE X-AXIS.  ALL LABEL ARRAYS ARE STANDARDIZED AT 48
C         CHARACTERS (6A8) EACH AND MAY BE USED FOR LABELS, DIMENSIONS
C         OR OTHER INFORMATION.  THE Y-AXIS LABEL IS SPLIT INTO THREE
C         PARTS OF 16 CHARACTERS EACH TO KEEP THE FINISHED PLOT WITHIN
C         AN 8.5 BY 11 INCH LIMIT.  SMOOTH AXIS LABELING IS PERFORMED
C         BY SUBROUTINE LABEL.
C
C         EXACTLY N DATA POINTS ARE PLOTTED AS SPECIFIED BY THE
C         ARGUMENTS X AND Y.  NO DATA SMOOTHING OR INTERPOLATION IS
C         PERFORMED BY THIS ROUTINE.  THERE ARE NO RESTRICTIONS ON THE
C         FORM OF THE FUNCTION REPRESENTED BY X AND Y.
C
C
```

```
C          BUFF    = 81 CHARACTER PRINT BUFFER WITH A PLOT SYMBOL SET AT
C                       EACH RELATIVE X POSITION FOR ANY DATA POINT HAVING
C                       A VALUE OF Y CORRESPONDING TO NY
C          DIV     = ARGUMENT, A FACTOR WHICH GIVES THE RELATIONSHIP
C                       BETWEEN THE TWO X AXES TO BE PRINTED IF II=1.
C                       THE LABELS GENERATED FOR THE FIRST X AXIS ARE
C                       DIVIDED BY DIV TO PRODUCE THE LABELS FOR THE
C                       SECOND AXIS.
C          DX      = COMPUTED GRID SIZE ALONG X-AXIS
C          DY      = COMPUTED GRID SIZE ALONG Y-AXIS
C          IBLNK   = INTEGER DATA WORD CONTAINING BLANKS (A4) USED TO
C                       INITIALIZE PRINT BUFFER
C          II      = ARGUMENT, SWITCH USED TO SELECT (II=1) OR SUPPRESS
C                       (II=0) PRINTING OF SECOND X AXIS
C          ISW     = ALTERNATING VARIABLE (+1,-1) USED FOR FORMAT CONTROL
C                       ON ALTERNATING LINES
C          J       = INTEGER INDEX, GENERAL
C          JY      = INTEGER INDEX DECREMENTED TO DISPLAY Y AXIS LABELS
C                       FROM TOP OF PAGE DOWN
C          KX      = COMPUTED INTEGER POSITION IN PRINT BUFFER WHICH
C                       CORRESPONDS TO X COORDINATE OF DATA POINT
C          KY      = COMPUTED INTEGER POSITION ALONG VERTICAL SCALE
C                       WHICH CORRESPONDS TO Y COORDINATE OF DATA POINT
C          N       = ARGUMENT, NUMBER OF DATA POINTS TO BE DISPLAYED
C          NY      = INTEGER INDEX CORRESPONDING TO VERTICAL SCALE, VARIES
C                       FROM 41 TO 1 FROM THE TOP DOWN
C          NYY     = DUMMY INDEX LOOP FROM 1 TO 41 USED TO OBTAIN NY
C          PLOT    = SYMBOL USED FOR DATA POINT DISPLAY
C          PTITL   = ARGUMENT, 48 CHARACTER PLOT TITLE
C          X       = ARGUMENT, ARRAY OF VALUES OF X COORDINATES, N POINTS
C          XMAX    = UPPER LIMIT OF X AXIS (IS GENERALLY EQUAL TO OR
C                       GREATER THAN THE MAXIMUM OF X(J))
C          XMIN    = LOWER LIMIT OF X AXIS (IS GENERALLY EQUAL TO OR
C                       LESS THAN THE MINIMUM OF X(J))
C          XSCL    = ARRAY OF VALUES FOR LABELS ALONG FIRST ABSCISSA
C          XSCL1   = ARRAY OF VALUES FOR LABELS ALONG SECOND ABSCISSA
C          XTITL   = ARGUMENT, 48 CHARACTER TITLE FOR FIRST ABSCISSA
C          XTITL1  = ARGUMENT, 48 CHARACTER TITLE FOR SECOND ABSCISSA
C          Y       = ARGUMENT, ARRAY OF VALUES OF Y COORDINATES, N POINTS
C          YMAX    = UPPER LIMIT OF Y AXIS (SEE XMAX)
C          YMIN    = LOWER LIMIT OF Y AXIS (SEE XMIN)
C          YSCL    = ARRAY OF VALUES FOR LABELS ON ORDINATE
C          YTITL   = ARGUMENT, 48 CHARACTER TITLE FOR ORDINATE
C
C          COMMON VARIABLES USED - LP
C
C          SUBROUTINES REQUIRED  - LABEL,PAGER
C
C          AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                               35/309A ACORN PARK,
C                               CAMBRIDGE, MASS., 02140
C                               TEL. 617-864-5770  EXT. 2813
C          DATE    - 16 OCTOBER 1975
C          REVISION - 12 MARCH 1980 (SCALE TO 80 CHAR PLOTS)
C
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
C
     0DIMENSION BUFF(61),PTITL(6),X(1),XSCL(7),XSCL1(7),XTITL(6),
     1              XTITL1(6),Y(1),YSCL(21),YTITL(6)
      INTEGER       BUFF,PLOT
      EQUIVALENCE (XMIN,XSCL(1)),(XMAX,XSCL(7))
      EQUIVALENCE (YMIN,YSCL(1)),(YMAX,YSCL(21))
      DATA          IBLNK/4H    /,PLOT/4H0   /
C
C
C---------SET UP X AND Y AXES FOR EVEN LABELS AND COMPUTE GRID SIZES
      CALL LABEL(X,N,XSCL,6)
      DX=(XMAX-XMIN)/60.
      CALL LABEL(Y,N,YSCL,20)
      DY=(YMAX-YMIN)/40.
```

```
C
C--------WRITE PLOT TITLE AND AXIS LINE
      CALL PAGER (0)
      WRITE(LP,1000) (YTITL(I),I=1,4),(PTITL(I),I=1,6),YTITL(5),YTITL(6)
      WRITE(LP,1010)
C
C--------SET UP AND LOOP ON Y SCALE.    CLEAR PRINT BUFFER EACH TIME
      JY=22
      ISW=-1
      DO 70 NYY=1,41
      NY=42-NYY
      ISW=-ISW
      DO 10 J=1,61
   10 BUFF(J)=IBLNK
C
C--------LOOP THROUGH ALL DATA POINTS.  IF Y COORDINATE MATCHES
C        CURRENT PRINT LINE, SET PLOT SYMBOL IN POSITION CORRESPONDING
C        TO X COORDINATE.
      DO 20 J=1,N
      KY=(Y(J)-YMIN)/DY+1.5
      IF(KY.NE.NY) GO TO 20
      KX=(X(J)-XMIN)/DX+1.5
      BUFF(KX)=PLOT
   20 CONTINUE
C
C--------SELECT TYPE OF PRINT LINE
      IF(ISW.LT.0) GO TO 30
      JY=JY-1
      WRITE(LP,1020) YSCL(JY),BUFF
      GO TO 70
   30 CONTINUE
      WRITE(LP,1030) BUFF
   70 CONTINUE
C
C--------CLOSE OFF PLOT WITH SINGLE OR DOUBLE X-AXIS LABELS
      WRITE(LP,1040)
      WRITE(LP,1060) XSCL,XTITL
      IF(II.EQ.0) RETURN
      DO 80 J=1,7
   80 XSCL1(J)=XSCL(J)/DIV
      WRITE(LP,1060) XSCL1,XTITL1
      RETURN
C
C--------BLANK SUBSTITUTED FOR +
 1000 FORMAT (///1X,2A8/1X,2A8,9X,6A8/1X,2A8/4X,7(9X,1H ))
C--------BLANK SUBSTITUTED FOR *
 1010 FORMAT (12X,63(1H ))
C--------TWO BLANKS SUBSTITUTED FOR *+
 1020 FORMAT (1X,1PE9.2,3H +*,61A1,2H  )
C--------BLANK SUBSTITUTED FOR *
 1030 FORMAT (12X,1H*,61A1,1H )
 1040 FORMAT (12X,63(1H*))
 1060 FORMAT (4X,7(9X,1H+)/7X,7(1X,1PE9.2)/19X,6A8)
C
      END
      SUBROUTINE SEGLOD(NSEG)
C
C        INTERFACE ROUTINE TO SEGMENT LOAD FUNCTION WHERE NSEG GIVES
C        THE NUMBER OF THE SEGMENT TO BE LOADED.  ALL CALLS TO THE
C        SEGMENT LOAD FUNCTION ARE CODED WITHIN EACH OVERLAY REQUIRING
C        SEGMENTS, AND THE SELECTION IS USUALLY BASED ON THE RATE MODEL
C        INDEX MODNO.  THE SEGMENT INDEX LIST SGLST ORIGINALLY DEFINED
C        FOR THIS PURPOSE IS NOT GENERALLY USED.
C
C        COMMON VARIABLES USED - NONE
C
C        SUBROUTINES REQUIRED  - UFSEG
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
```

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C          DATE    - 16 OCTOBER 1975
C
      IF(NSEG.LE.0) RETURN
      CALL OVERLAY(6HUIMABS,8,NSEG,6HRECALL)
      RETURN
      END
      SUBROUTINE TOXIC(C,IFLAG,AM,XCONC)
C
C     THIS SUBROUTINE CONVERTS CONCENTRATIONS OF A VAPOR IN AIR FROM UNI
C     OF GM/CM**3. TO UNITS OF PPM OR MOLE PERCENT
C
C****INPUTS
C
C     C        THE CONCENTRATION IN GM/CM**3. WHOSE UNITS ARE TO BE CONVE
C     IFLAG    FLAG INDICATING WHETHER DESIRED OUTPUT IS TO BE IN UNITS O
C                PPM OR MOLE PERCENT. IFLAG=0 FOR MOLE PERCENT,IFLAG=1 FO
C     AM       MOLECULAR WEIGHT OF THE CHEMICAL
C
C****OUTPUTS
C
C     XCONC    THE CONCENTRATION DESIRED IN EITHER UNITS OF MOLE PERCENT
C
      DENA=0.0012894
      DENV=AM/22414.
      XCONC=1./(1.+((AM/28.9)*(DENA/C)*(1.-(C/DENV))))
      IF(IFLAG-0) 20,20,10
   10 XCONC=XCONC*1000000.
      GO TO 30
   20 XCONC=XCONC*100.
   30 RETURN
      END
      SUBROUTINE TRACE(ISW,NOV,NSEG)
C
C          SUBROUTINE TRACE PROVIDES LINE PRINTER MESSAGES FOR DIAGNOSTIC
C          TESTING OF HACS OVERLAY FUNCTION.  SUBROUTINE CALLS ARE CODED
C          AT THE BEGINNING AND END OF EACH OVERLAY TO BRANCH TO THIS
C          ROUTINE TO SELECT AN AUDIT MESSAGE FOR THE STATUS OF EACH
C          OVERLAY AND SEGMENT.  A RETURN STATEMENT HAS BEEN INSERTED AS
C          THE FIRST EXECUTABLE STATEMENT TO OVER-RIDE THIS DIAGNOSTIC
C          FUNCTION FOR USER RUNS.
C
C          ISW     = MESSAGE CONTROL SWITCH, 0 TO FORCE STARTING MESSAGE,
C                      1 TO SELECT ENDING MESSAGE
C          NOV     = OVERLAY NUMBER SET IN CALLING PROGRAM
C          NSEG    = SEGMENT NUMBER SET IN CALLING PROGRAM
C
C          COMMON VARIABLES USED - LP
C
C          SUBROUTINES REQUIRED  - PAGER
C
C          AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                               35/309A ACORN PARK,
C                               CAMBRIDGE, MASS., 02140
C                               TEL. 617-864-5770  EXT. 2813
C          DATE    - 2 DECEMBER 1975
C
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      RETURN
      CALL PAGER(1)
      IF(ISW.EQ.1) GO TO 10
      WRITE(LP,1000) NOV,NSEG
      RETURN
   10 WRITE(LP,1010) NOV,NSEG
      RETURN
C
 1000 FORMAT (5X,42H*****OVERLAY TRACE, NOW EXECUTING OVERLAY ,I2,
     1  9H SEGMENT ,I2)
 1010 FORMAT (5X,37H*****OVERLAY TRACE, FINISHED OVERLAY ,I2,
     1  9H SEGMENT ,I2)
      END
```

```
      LOGICAL FUNCTION ENTR(J)
C           READS TERMINAL INPUT INTO
C           BUFFER FOR CHARACTER SCAN
     OCOMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      EQUIVALENCE (DEC,SPLST(13)),(EXP,SPLST(14))
      EQUIVALENCE (MINUS,SPLST(12)),(PLUS,SPLST(11))
C---------CLEAR EOF INDICATOR
      IN=5
      IF(EOF(IN)) 10,10
C---------INITIALIZE BUFFER
   10 DO 20 I=1,80
   20 BUFF(I)=BLANK
      READ(IN,1000) BUFF
      PTR=0
C---------SEE IF INPUT FOUND
   30 IF(NEXT(0)) 30,40,50
   40 ENTR=.FALSE.
      RETURN
   50 ENTR=.TRUE.
      PTR=0
      RETURN
 1000 FORMAT (80A1)
      END
      LOGICAL FUNCTION FLTPT(VALUE)
C---------RETURNS .TRUE. WITH VALID REAL NUMBER AS VALUE
C---------.FALSE. OTHERWISE
     OCOMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      EQUIVALENCE (DEC,SPLST(13)),(EXP,SPLST(14))
      EQUIVALENCE (MINUS,SPLST(12)),(PLUS,SPLST(11))
      LOGICAL INTEGR
C---------INITIALIZE FOR VALID RETURN
      FLTPT=.TRUE.
C---------SKIP TO NEXT NON-BLANK INPUT CHARACTER
   10 IF(NEXT(0)) 10,150,20
C---------INITIALIZE
   20 TEMP=0.0
      VALUE=0.0
      ISIGN=1
C---------CHECK FOR OPTIONAL SIGN
      IF(CHAR.EQ.PLUS) GO TO 30
      IF(CHAR.NE.MINUS) GO TO 40
      ISIGN=-1
C---------NEED NEXT INPUT, MAY BE DECIMAL POINT OR DIGIT
   30 IF(NEXT(0)) 150,150,40
   40 IF(TYP.NE.1) GO TO 50
C---------PROCESS DIGITS PRECEEDING DECIMAL POINT
      TEMP=10.*TEMP+NUM
      IF(NEXT(0)) 130,130,40
C---------CHECK FOR DECIMAL POINT OR EXPONENT
   50 IF(CHAR.EQ.EXP) GO TO 75
      IF(CHAR.NE.DEC) GO TO 140
      PT=1.0
C---------PROCESS DIGITS FOLLOWING DECIMAL POINT
   60 IF(NEXT(0)) 130,130,65
   65 IF(TYP.NE.1) GO TO 70
      PT=PT/10.
      TEMP=TEMP+PT*NUM
      GO TO 60
C---------TEST AND PROCESS OPTIONAL EXPONENT
   70 IF(CHAR.NE.EXP) GO TO 140
   75 IF(.NOT.INTEGR(IEXP)) GO TO 150
      IF(IEXP) 80,130,90
   80 EXBS=0.1
      IEXP=-IEXP
      GO TO 100
   90 EXBS=10.
```

```
  100 DO 110 J=1,IEXP
  110 TEMP=TEMP*EXBS
C---------STORE RESULT AND RETURN
  130 VALUE=TEMP*ISIGN
      RETURN
C---------BAD CHARACTER ERROR, ADVANCE TO BLANK OR EOR
  140 IF(NEXT(0)) 150,150,140
C---------ERROR ON BLANK OR EOR
  150 FLTPT=.FALSE.
      OUT=6
      WRITE(OUT,1000)
      RETURN
 1000 FORMAT (29H WHAT? (DECIMAL SYNTAX ERROR))
      END
      LOGICAL FUNCTION INTEGR(IRESLT)
C---------RETURNS .TRUE. WITH VALID INTEGER AS IRESLT
C---------RETURNS .FALSE. FOR INVALID INTEGER WITH IRESLT = 0
     0COMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      EQUIVALENCE (DEC,SPLST(13)),(EXP,SPLST(14))
      EQUIVALENCE (MINUS,SPLST(12)),(PLUS,SPLST(11))
C---------INITIALIZE FOR VALID RETURN
      INTEGR=.TRUE.
C---------SKIP TO NEXT NON-BLANK INPUT CHARACTER
   10 IF(NEXT(0)) 10,70,20
C---------INITIALIZE
   20 IRESLT=0
      ITEMP=0
      ISIGN=1
C---------CHECK FOR OPTIONAL SIGN
      IF(CHAR.EQ.PLUS) GO TO 30
      IF(CHAR.NE.MINUS) GO TO 40
      ISIGN=-1
C---------NEED NEXT INPUT, MUST BE VALID DIGIT
   30 IF(NEXT(0)) 70,70,40
   40 IF(TYP.NE.1) GO TO 60
C---------ADD DIGIT TO INTEGER RESULT
      ITEMP=10*ITEMP+NUM
C---------GET NEXT INPUT
      IF(NEXT(0)) 50,50,40
C---------HAVE RESULT, STOPPED ON BLANK OR EOR
   50 IRESLT=ISIGN*ITEMP
      RETURN
C---------BAD CHARACTER ERROR, ADVANCE TO BLANK OR EOR
   60 IF(NEXT(0)) 70,70,60
C---------ERROR ON BLANK OR EOR
   70 INTEGR=.FALSE.
      OUT=6
      WRITE(OUT,1000)
      RETURN
 1000 FORMAT (29H WHAT? (INTEGER SYNTAX ERROR))
      END
      LOGICAL FUNCTION NAME(TAG)
C---------READS UP TO 10 CHARACTER NAME IN A1 FORMAT
C---------RETURNS RESULT IN A10 FORMAT, BLANK FILL RIGHT
C---------RETURNS .FALSE. IF NO INPUT, .TRUE. OTHERWISE
      DIMENSION MASK(10)
      INTEGER TAG
     0COMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      EQUIVALENCE (DEC,SPLST(13)),(EXP,SPLST(14))
      EQUIVALENCE (MINUS,SPLST(12)),(PLUS,SPLST(11))
      DATA MASK ( 1)/77000000000000000000B/
      DATA MASK ( 2)/00770000000000000000B/
      DATA MASK ( 3)/00007700000000000000B/
      DATA MASK ( 4)/00000077000000000000B/
      DATA MASK ( 5)/00000000770000000000B/
      DATA MASK ( 6)/00000000007700000000B/
```

```
      DATA MASK ( 7)/00000000000077000000B/
      DATA MASK ( 8)/00000000000000770000B/
      DATA MASK ( 9)/00000000000000007700B/
      DATA MASK (10)/00000000000000000077B/
C---------SKIP TO NON-BLANK
   10 IF(NEXT(0)) 10,70,20
C---------INITIALIZE PACKING
   20 TAG=0B
      I=0
      ISHFT=0
C---------PACK CHARACTER I
   30 I=I+1
      ITEMP=SHIFT(CHAR,ISHFT)
      ITEMP=ITEMP.AND.MASK(I)
      TAG=TAG.OR.ITEMP
      ISHFT=ISHFT-6
C---------TESTS FOR END
      IF(CHAR.EQ.BLANK) GO TO 50
      IF(I.GE.10) GO TO 80
C---------GET NEXT CHAR TO BE PACKED
      IF(NEXT(0)) 40,40,30
   40 CHAR=BLANK
      GO TO 30
C---------LAST CHAR PACKED WAS BLANK
C         CONTINUE WITH BLANK FILL TO END
   50 IF(I.LT.10) GO TO 30
   60 NAME=.TRUE.
      RETURN
C---------RETURN FOR EMPTY INPUT RECORD
   70 TAG=BLANK
      NAME=.FALSE.
      RETURN
C---------AFTER TENTH CHARACTER IS PACKED,
C         MOVE TO EOR OR FIRST BLANK CHARACTER
C         IN INPUT.
   80 IF(NEXT(0)) 60,60,80
      RETURN
      END
      FUNCTION NEXT(J)
C---------SCANS INPUT FOR NEXT CHARACTER.
C         VALUE = -1 FOR BLANK
C         VALUE =  0 FOR EOR
C         VALUE = +1 FOR NON-BLANK AND ALSO GIVES
C                        CHAR, NUM, TYP
     0COMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      EQUIVALENCE (DEC,SPLST(13)),(EXP,SPLST(14))
      EQUIVALENCE (MINUS,SPLST(12)),(PLUS,SPLST(11))
C---------INCREMENT POINTER AND TEST FOR EOR
      PTR=PTR+1
      IF(PTR.GT.80) GO TO 20
C---------TEST FOR BLANK
      IF(BUFF(PTR).EQ.BLANK) GO TO 30
C---------HAVE NON BLANK CHARACTER. SET NUMBER AND
C         TYPE FOR SPECIAL CHARACTERS, TYPE 6
C         FOR ALL OTHERS.
      NEXT=1
      CHAR=BUFF(PTR)
      DO 10 I=1,14
      IF(CHAR.NE.SPLST(I)) GO TO 10
      NUM=I-1
      TYP=1
      IF(I.GT.10) TYP=I-9
      RETURN
   10 CONTINUE
      TYP=6
      RETURN
C---------EOR RETURN
   20 NEXT=0
      GO TO 40
```

```
C---------BLANK RETURN
   30 NEXT=-1
   40 CHAR=BLANK
      RETURN
      END
      LOGICAL FUNCTION YESNO(J)
C---------RETURNS .TRUE. FOR YES, .FALSE. FOR NO
      LOGICAL ENTR
     0COMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      EQUIVALENCE (DEC,SPLST(13)),(EXP,SPLST(14))
      EQUIVALENCE (MINUS,SPLST(12)),(PLUS,SPLST(11))
C---------DISPLAY PROMPT
   10 CONTINUE
      OUT=6
C---------READ INPUT
      IF(.NOT.ENTR(0)) GO TO 50
C---------SKIP TO FIRST NON-BLANK, OR EOR
   20 IF(NEXT(0)) 20,50,30
C---------RETURN IF Y OR N
   30 IF(CHAR.NE.YES) GO TO 40
      YESNO=.TRUE.
      RETURN
   40 IF(CHAR.NE.NO) GO TO 50
      YESNO=.FALSE.
      RETURN
   50 CONTINUE
      OUT=6
      WRITE(OUT,1010)
      WRITE(OUT,1000)
      GO TO 10
C
 1000 FORMAT (23H ENTER YES OR NO (Y/N):)
 1010 FORMAT (6H WHAT?)
      END
      BLOCK DATA
     0COMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      EQUIVALENCE (DEC,SPLST(13)),(EXP,SPLST(14))
      EQUIVALENCE (MINUS,SPLST(12)),(PLUS,SPLST(11))
      DATA BLANK/1H /,IN/5/,NO/1HN/,OUT/6/,YES/1HY/
     0DATA (SPLST(I),I=1,14)/1H0,1H1,1H2,1H3,1H4,
     1  1H5,1H6,1H7,1H8,1H9,1H+,1H-,1H.,1HE/
      END
      SUBROUTINE EXPLAIN(NMSG)
      DIMENSION   MSG(71),TXT(70)
      INTEGER     ONE,TERM,THR,TWO,TXT
      EQUIVALENCE (MSG(2),TXT(1))
     0DATA        MSG(1)/10H(5X,     '/,ONE/1H1/,TERM/2H')/,THR/1H3/,
     1            TWO/1H2/
      CALL READMS(11,TXT,69,NMSG)
      NW=LENGTH(11)
      IF(TXT(1).EQ.ONE) GO TO 10
      IF(TXT(1).EQ.TWO) GO TO 30
      NW=NW+1
      TXT(NW)=TERM
      IF(TXT(1).EQ.THR) GO TO 20
      WRITE(6,MSG)
      GO TO 40
   10 WRITE(6,1000)
      GO TO 40
   20 TXT(1)=MSG(1)
      WRITE(6,TXT)
   30 WRITE(6,1010)
   40 WRITE(6,1020)
      RETURN
 1000 FORMAT (5X,60HREFER TO HACS USER'S REFERENCE MANUAL FOR FIELD DESC
     1RIPTION.)
```

```
10100FORMAT (5X,58HREFER TO CHRIS MANUAL II FOR CHEMICAL PROPERTY DATA
     1ITEMS.)
 1020 FORMAT (5X)
      END
      LOGICAL FUNCTION QUEST(J)
     0COMMON/INTER/BLANK,BUFF(80),CHAR,IN,NO,
     1  NUM,OUT,PTR,SPLST(14),TYP,YES
      INTEGER BLANK,BUFF,CHAR,DEC,EXP
      INTEGER OUT,PLUS,PTR,SPLST,TYP,YES
      EQUIVALENCE (DEC,SPLST(13)),(EXP,SPLST(14))
      EQUIVALENCE (MINUS,SPLST(12)),(PLUS,SPLST(11))
C
      INTEGER QUERY
      DATA QUERY/10H?
C
      QUEST=.FALSE.
      IF(CHAR.EQ.QUERY) QUEST=.TRUE.
      RETURN
      END
      SUBROUTINE SNMSG(I)
C
C        SUBROUTINE PRINTS SCENARIO MESSAGES.  NOTE THAT THIS FUNCTION
C        COULD LIKELY BE COMBINED WITH SUBROUTINE EXPLAIN.
C
      DIMENSION MSG(71),TXT(70)
      INTEGER TERM,TXT
      EQUIVALENCE (MSG(2),TXT(1))
      DATA MSG(1)/10H(9X,      '/,TERM/2H')/
      CALL READMS(12,TXT,69,I)
      NW=LENGTH(12)
      NW=NW+1
      TXT(NW)=TERM
      WRITE(6,MSG)
      RETURN
      END
      SUBROUTINE INIT(CODE,I,J,K)
C
C        SUBROUTINE INIT INITIALIZES THE CODING ROUTINES TO STORE NEW
C        CODES, OR TO READ PREVIOUSLY STORED CODES, IN THE INTEGER
C        ARRAY CODE.  THE ARRAY CODE, MUST BE DIMENSIONED IN THE
C        CALLING PROGRAM TO BE OF LENGTH J OR GREATER.  THE CHARACTER-
C        ISTICS OF THE STORED NUMERIC CODES ARE SPECIFIED BY THE
C        REMAINING ARGUMENTS -
C
C        I       = MAXIMUM NUMBER OF BITS IN EACH WORD OF THE ARRAY CODE
C                    WHICH CAN BE USED FOR STORAGE OF CODED VALUES.
C        J       = MAXIMUM NUMBER OF WORDS IN ARRAY CODE WHICH ARE
C                    USED FOR STORAGE OF CODED VALUES.
C        K       = DEFINES THE STORAGE REQUIRED FOR A SINGLE CODED VALUE
C                    TO BE FIXED LENGTH AT K BITS PER CODE.  THIS DETER-
C                    MINES THE ALLOWED INTEGER MAGNITUDE OF EACH CODED
C                    VALUE TO BE GREATER THAN OR EQUAL TO ZERO, AND LESS
C                    THAN 2**K.
C
C        ON RETURN, THE ERROR FLAG IERR IN COMMON IS ZERO IF NO ERRORS
C        WERE ENCOUNTERED.  ERROR CONDITIONS WILL CAUSE IERR TO BE SET
C        TO 1,2,7,8 OR 9 ON RETURN, AND CONTROL VARIABLES IN COMMON
C        TO BE SET FOR SINGLE BIT, SINGLE WORD CODE STORAGE.
C
C        SUBROUTINE INIT CONTAINS A SINGLE INTERNAL PARAMETER, MXWRD,
C        WHICH DEFINES THE MAXIMUM ALLOWED UNSIGNED INTEGER WORD
C        LENGTH IN BITS AND IS INSTALLATION DEPENDENT.  FOR A NORMAL
C        16-BIT WORD LENGTH, MXWRD SHOULD BE SET TO 15.  FOR USE WITH
C        DOUBLE PRECISION (TWO-WORD) INTEGERS, MXWRD CAN BE SET TO 31
C        FOR A 16-BIT WORD LENGTH IF INTEGER SPECIFICATIONS ARE ALSO
C        MODIFIED IN THESE ROUTINES.  FOR USE ON THE CDC CYBERNET NET-
C        WORK, INTEGER ARITHMETIC IS LIMITED TO PARTIAL WORDS, SO MXWRD
C        IS SET TO 47 OUT OF 60 BITS AVAILABLE IN THE FULL WORD.
C
C        SUBROUTINE INIT MUST BE CALLED ONCE AND ONLY ONCE FOR EACH
C        CODED ARRAY PRIOR TO ALL CALLS USING THE ROUTINES SET, RSET
C        OR ITST WITH THE CODED ARRAY.  NOTE THAT INIT WILL CLEAR THE
```

```
C         CONTENTS OF THE REFERENCED CODED ARRAY.  INIT MUST BE CALLED
C         IMMEDIATELY BEFORE EACH CALL TO THE BULK TRANSFER ROUTINES
C         PACK AND UNPK.
C
C         COMMON VARIABLES USED - CDLN,CPW,IERR,L,MAXN,MAXV
C
C         SUBROUTINES REQUIRED  - NONE
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER       CPW,CDLN,SHFT
C
      INTEGER       CODE(1)
      DATA          MXWRD/47/
C
C
C--------TEST LENGTH OF WORD TO BE USED FOR CODE STORAGE.  CANNOT BE
C         LESS THAN 1 OR EXCEED MAXIMUM UNSIGNED INTEGER WORD LENGTH.
      IF(I.LE.0) GO TO 20
      IF(I.GT.MXWRD) GO TO 30
C
C--------TEST NUMBER OF WORDS TO BE USED FOR CODE STORAGE.  CANNOT BE
C         LESS THAN 1.  UPPER LIMIT IS NOT TESTED SINCE THIS IS
C         CONTROLLED BY USER DIMENSION IN CALLING PROGRAM.
      IF(J.LE.0) GO TO 40
C
C--------TEST NUMBER OF BITS TO BE USED FOR SINGLE CODE.  CANNOT BE
C         LESS THAN 1 OR EXCEED SPECIFIED LENGTH OF CODE WORD.
      IF(K.LE.0) GO TO 50
      IF(K.GT.I) GO TO 60
C
C--------NORMAL RETURN.  COMPUTE NUMBER OF CODES TO BE STORED PER
C         WORD (CPW), INITIALIZE ALL CODE WORDS TO ZERO, AND SET NORMAL
C         ERROR RETURN.  COMPUTE TOTAL NUMBER OF CODES WHICH CAN BE
C         STORED (MAXN), MOVE CODE LENGTH K TO COMMON VARIABLE CDLN,
C         AND COMPUTE MAXIMUM ALLOWED CODE VALUE (MAXV).
      IERR=0
      CPW=I/K
      DO 10 L=1,J
   10 CODE(L)=0
      MAXN=CPW*J
      CDLN=K
      MAXV=2**CDLN-1
      RETURN
C
C--------ERROR RETURNS.  SET VALUE OF ERROR SWITCH IN COMMON AND
C         DEFAULT TO CODE DEFINITION USING SINGLE WORD CONTAINING CODES
C         ONE BIT IN LENGTH.
   20 IERR=1
      GO TO 70
   30 IERR=2
      GO TO 70
   40 IERR=7
      GO TO 70
   50 IERR=8
      GO TO 70
   60 IERR=9
   70 CPW=MXWRD
      CODE(1)=0
      MAXN=MXWRD
      CDLN=1
      MAXV=1
      RETURN
      END
      LOGICAL FUNCTION ECHK(N)
C
C         LOGICAL FUNCTION ECHK (FOR ERROR CHECK) TESTS THE REQUESTED
C         CODE POSITION SPECIFIED BY THE ARGUMENT N.  IF THE POSITION
C         IS NOT WITHIN THE ALLOWED NUMBER OF CODED VALUES (1 TO MAXN),
C         THE ERROR INDICATOR IERR IN COMMON IS SET TO 3 OR 4 AND THE
C         FUNCTION RETURNS A VALUE OF .TRUE.  ALL OTHER VARIABLES IN
C         COMMON ARE UNCHANGED.
```

```
C
C        IF THE SPECIFIED CODE POSITION, N, IS VALID, THE ERROR CHECK
C        FUNCTION RETURNS A VALUE OF .FALSE. AND SETS VARIABLES IN
C        COMMON TO ACCESS THE VALUE OF THE NTH CODE PACKED IN AN ARRAY.
C        GIVEN N, THE LOCATION OF THE CODED VALUE IS DETERMINED BY THE
C        NUMBER OF CODED VALUES PER STORAGE WORD (CPW) AND THE LENGTH
C        OF EACH CODE (CDLN).  BOTH CPW AND CDLN ARE DETERMINED ON
C        INITIALIZATION IN SUBROUTINE INIT.  FOR ACCESSING THE REQUESTED
C        CODE THE FUNCTION RETURNS L AND SHFT.  THE VALUE OF L IS THE
C        SUBSCRIPT INDEX TO THE WORD OF THE PACKED ARRAY CONTAINING
C        THE POSITION FOR THE CODED VALUE.  SHFT IS AN INTEGER MULTI-
C        PLIER OR DIVISOR WHICH WILL MOVE A CODED VALUE OF LENGTH CDLN
C        TO OR FROM ITS POSITION IN WORD L FROM OR TO THE LOW ORDER
C        NUMERIC POSITION.
C
C        COMMON VARIABLES USED - CDLN,CPW,IERR,L,MAXN,SHFT,ITMP
C
C        SUBROUTINES REQUIRED  - NONE
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER      CPW,CDLN,SHFT
      EQUIVALENCE  (I,IPOS,ITMP)
C
C
C--------TEST REQUESTED CODE POSITION.  MUST LIE WITHIN DEFINED
C        BOUNDARY OF CODE WORD STRUCTURE.
      IF(N.LE.0) GO TO 10
      IF(N.GT.MAXN) GO TO 20
C
C--------NORMAL RETURN.  SET ERROR CODE AND FUNCTION VALUE.
      IERR=C
      ECHK=.FALSE.
C
C--------COMPUTE WORD ADDRESS (L) WITHIN CODE LIST ARRAY, AND POSITION
C        ADDRESS (IPOS) WITHIN WORD L FOR CODE LOCATION N.
      I=N-1
      L=I/CPW
      IPOS=I-L*CPW
      L=L+1
C
C--------COMPUTE SHIFT FACTOR TO ACCESS CODE N IN POSITION IPOS OF
C        WORD L.
      I=CDLN*IPOS
      SHFT=2**I
      RETURN
C
C--------ERROR RETURNS.
   10 IERR=3
      GO TO 30
   20 IERR=4
   30 ECHK=.TRUE.
      RETURN
      END
      FUNCTION ITST(CODE,N)
C
C        FUNCTION ITST RETURNS THE INTEGER VALUE OF CODE N STORED IN
C        A PACKED ARRAY CODE.  IF N IS NOT WITHIN THE RANGE OF THE
C        PACKED CODES, A VALUE OF ZERO IS RETURNED FOR ITST AND IERR
C        IS SET TO 3 OR 4.  IF N IS VALID, THE VALUE OF ITST IS OBTAINED
C        FROM THE PACKED CODE IN POSITION N IN THE RANGE 0 TO MAXV, AND
C        IERR IS RETURNED AS ZERO.  DEFINITION OF THE PACKED CODE
C        STRUCTURE IS OBTAINED FROM THE MOST RECENT CALL TO SUB-
C        ROUTINE INIT.
C
C        COMMON VARIABLES USED - ITMP,L,MAXV,SHFT
C
C        SUBROUTINES REQUIRED  - ECHK
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER      CPW,SHFT,CDLN
```

```
C
      INTEGER       CODE(1)
      LOGICAL       ECHK
C
C
C--------INITIALIZE FUNCTION VALUE AND RETURN IF N IS INVALID.
      ITST=0
      IF(ECHK(N)) RETURN
C
C--------MOVE CODED VALUE IN WORD L TO LOW ORDER POSITION OF ITMP.
      ITMP=CODE(L)/SHFT
C
C--------OBTAIN CODED VALUE BY REMOVING ANY BITS REMAINING IN HIGHER
C           ORDER POSITIONS.
      ITST=ITMP.AND.MAXV
      RETURN
      END
      SUBROUTINE SUMRY
C
C        COMMON VARIABLES USED - ICD,LP,MODEL,PTLST,SNCOD
C
C        SUBROUTINES REQUIRED  - INIT,ITST,PAGER,SNMSG,SPRNT,YESNO
C
C        DATE   - 23 JANUARY 1981
C
C
C
     0COMMON/CNTRL/EOFF,ICD,IDFLT,LBL(4),LSTCN(3,3),MODEL(15),NOP,
     1             STCON,SVCON
      INTEGER       EOFF,STCON,SVCON
      REAL          LBL
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/NAME/PTLST(30),SOURCE(7)
      INTEGER      PTLST
C
      COMMON/PXFER/BUFF(15),K1,SNCOD
      INTEGER       BUFF,SNCOD
C
C
      DIMENSION ITXT(5),IVAL(5),SCLST(28)
      INTEGER    SCLST
      LOGICAL    YESNO
C
     0DATA (SCLST(I),I=1,28)/3HA B,3HA C,5HA B C,5HA D E,7HA D F G,
     1     9HA D E F G,3HA H,5HA I J,7HA H I J,5HA K L,7HA K M N,
     2     9HA K L M N,3HA O,3HA P,5HA P Q,7HA P R S,9HA P Q R S,
     3     3HA T,5HA T U,5HA V W,9HA T U V W,3HA X,5HA X Y,1HZ,2HII,
     4     2HRR,4HRR C,2HSS/
C
C
      CALL PAGER(2)
      WRITE(LP,1000)
      IF(.NOT.YESNO(0)) RETURN
      DO 10 I=1,5
      IVAL(I)=0
   10 ITXT(I)=0
      CALL PAGER(2)
      WRITE(LP,1010)
      CALL PAGER(2)
      WRITE(LP,1020)
      IF(.NOT.YESNO(0)) GO TO 20
      IVAL(1)=1
      CALL PAGER(2)
      WRITE(LP,1030)
      IF(YESNO(0)) ITXT(1)=1
   20 CALL PAGER(2)
      WRITE(LP,1040)
      IF(.NOT.YESNO(0)) GO TO 30
      IVAL(2)=1
      CALL PAGER(2)
      WRITE(LP,1030)
```

```
      IF(YESNO(0)) ITXT(2)=1
   30 CALL PAGER(2)
      WRITE(LP,1050)
      IF(.NOT.YESNO(0)) GO TO 40
      IVAL(3)=1
      CALL PAGER(2)
      WRITE(LP,1030)
      IF(YESNO(0)) ITXT(3)=1
   40 CALL PAGER(2)
      WRITE(LP,1060)
      IF(.NOT.YESNO(0)) GO TO 50
      IVAL(4)=1
      CALL PAGER(2)
      WRITE(LP,1030)
      IF(YESNO(0)) ITXT(4)=1
   50 CALL PAGER(2)
      WRITE(LP,1080)
      IF(.NOT.YESNO(0)) GO TO 70
      IVAL(5)=1
      CALL PAGER(2)
      WRITE(LP,1030)
      IF(YESNO(0)) ITXT(5)=1
C---------START REPORT
   70 CALL PAGER(0)
      CALL PAGER(7)
      WRITE(LP,1090) ICD
C--------SCENARIO SUMMARY
      IF(IVAL(1).EQ.0) GO TO 90
      CALL PAGER(4)
      WRITE(LP,1100)
      CALL INIT(ITMP,28,1,1)
      DO 80 I=1,28
      ITMP=ITST(SNCOD,I)
      IF(ITMP.EQ.0) GO TO 80
      CALL PAGER(3)
      WRITE(LP,1110) SCLST(I)
      IF(ITXT(1).EQ.1) CALL SNMSG(I)
   80 CONTINUE
C--------MODEL SUMMARY
   90 IF(IVAL(2).EQ.0) GO TO 110
      CALL PAGER(4)
      WRITE(LP,1120)
      DO 100 I=1,15
      J=MODEL(I)
      IF(J.GE.30) GO TO 100
      IF(J.LE.0) GO TO 100
      CALL PAGER(3)
      WRITE(LP,1130) PTLST(J)
      IF(ITXT(2).EQ.1) CALL MODEXP(J)
  100 CONTINUE
C--------USER INPUT SUMMARY
  110 IF(IVAL(3).EQ.0) GO TO 120
      CALL PAGER(4)
      WRITE(LP,1150)
      CALL SPRNT(5,5,ITXT(3))
C--------COMPUTED VALUE SUMMARY
  120 IF(IVAL(4).EQ.0) GO TO 130
      CALL PAGER(4)
      WRITE(LP,1160)
      CALL SPRNT(2,6,ITXT(4))
C--------CHEMICAL PROPERTY VALUES
  130 IF(IVAL(5).EQ.0) GO TO 150
      CALL PAGER(4)
      WRITE(LP,1180)
      CALL SPRNT(2,3,ITXT(5))
C---------END
  150 CALL PAGER(5)
      WRITE(LP,1190)
      RETURN
C
 1000 FORMAT (/49H DO YOU WANT TO PRINT A SUMMARY OF THESE RESULTS?)
 1010 FORMAT (/38H   WHICH OF THE FOLLOWING DO YOU WANT?)
```

```
 1020 FORMAT (/18H   SCENARIO CODES?)
 1030 FORMAT (/28H      WITH TEXT DESCRIPTIONS?)
 1040 FORMAT (/15H   MODEL CODES?)
 1050 FORMAT (/21H   USER FIELD VALUES?)
 1060 FORMAT (/25H   COMPUTED FIELD VALUES?)
 1080 FORMAT (/28H   CHEMICAL PROPERTY FIELDS?)
 10900FORMAT (//1X,49(1H*)/47H SUMMARY OF HAZARD ASSESSMENT RUN FOR CHEM
     1ICAL ,A3/1X,49(1H*)//)
 11000FORMAT (/5X,44HAPPROPRIATE HAZARD ASSESSMENT SCENARIOS ARE:/5X,
     1 44(1H-)/)
 11200FORMAT (/5X,51HHAZARD ASSESSMENT MODELS UTILIZED IN THIS RUN WERE:
     1 /5X,51(1H-)/)
 1110 FORMAT (/5X,A10/)
 1130 FORMAT (/5X,A4/)
 1150 FORMAT (/5X,34HUSER INPUT DATA FOR THIS RUN WERE:/5X,34(1H-)/)
 1160 FORMAT (/5X,31HCOMPUTED RESULTS OBTAINED WERE:/5X,31(1H-)/)
 1180 FORMAT (/5X,38HCHEMICAL PROPERTY DATA AVAILABLE WERE:/5X,38(1H-)/)
 1190 FORMAT (1X,24(1H*)/25H END OF REQUESTED SUMMARY/1X,24(1H*)/)
      END
      SUBROUTINE SPRNT(IL,IH,IT)
C
C          CALL SPRNT(2,3,IT) GIVES PROPERTY REPORT
C          CALL SPRNT(2,6,IT) GIVES COMPUTED VALUE REPORT
C          CALL SPRNT(5,5,IT) GIVES USER VALUE REPORT
C
C         COMMON VARIABLES USED - FVAL,IVAL,LIST,LP,NF,NI,SOURC,UNIT
C
C         SUBROUTINES REQUIRED  - EXPLAIN,FCNV,PAGER
C
C         DATE    - 23 JANUARY 1981
C
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,NF,NI,LIST(275,6),
     1             FVAL(225,3),IVAL(50,3)
      INTEGER      UPTH
      REAL         MSG
      DIMENSION    STATE(2489)
      EQUIVALENCE  (STATE(1),MSG(1))
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER      PTLST
      ICNT=0
      NFLD=NI+NF
      DO 30 ILN=1,NFLD
      IFLD=LIST(ILN,1)
      IVAR=LIST(ILN,2)/1000
      IS=1000*IVAR
      ITYP=(LIST(ILN,2)-IS)/10
      IS=LIST(ILN,2)-10*ITYP-IS
C
C--------CONDITIONS FOR FIELD OUTPUT SELECTION DEPENDING ON TYPE OF
C         REPORT SELECTED.  STATEMENT 30 SKIPS FIELD, STATEMENT 5
C         SELECTS FIELD FOR REPORT.
      IF(IS.LT.IL) GO TO 30
      IF(IS.GT.IH) GO TO 30
      IF(IH.EQ.5) GO TO 5
      IF(IH.NE.3) GO TO 1
      IF(IFLD.EQ.2032) GO TO 5
      IF(IFLD.EQ.2033) GO TO 5
      IF(IFLD.GT.1999) GO TO 30
      IF(IFLD.LT.1002) GO TO 30
      GO TO 5
    1 IF(IS.EQ.5) GO TO 30
      IF(IFLD.EQ.2032) GO TO 30
      IF(IFLD.EQ.2033) GO TO 30
      IF(IFLD.LE.1999) GO TO 30
C
C--------FIELD SELECTED FOR OUTPUT
```

```
    5 ICNT=ICNT+1
      IX=LIST(ILN,6)
      IF(IVAR.EQ.0) GO TO 10
C--------DISPLAY REAL FIELD VALUE
      VAL=FVAL(IX,1)
      CALL FCNV(IFLD,ILN,VAL,ITYP,IS)
      GO TO 20
C--------DISPLAY INTEGER VALUE
   10 CALL PAGER(2)
     0WRITE(LP,1010) IFLD,(LIST(ILN,I),I=3,5),IVAL(IX,1),
     1               UNIT(1,ITYP),SOURC(IS+1)
C--------TEST FOR TEXT AUDIT
   20 IF(IT.EQ.1) CALL EXPLAIN(ILN)
   30 CONTINUE
C--------ADD MESSAGE IF NO OUTPUT IS PRINTED
      IF(ICNT.GT.0) RETURN
      CALL PAGER(1)
      WRITE(LP,1020)
      RETURN
C
 1010 FORMAT (5X,I4,1X,3A4,5H  =  ,I10,5X,A8,8H, IS A  ,A8,7H  VALUE/)
 1020 FORMAT (10X,13HNOT PERTINENT)
      END
      SUBROUTINE MODEXP(NMSG)
      DIMENSION MSG(192),TXT(191)
      INTEGER TERM,TXT
      EQUIVALENCE (MSG(2),TXT(1))
      DATA LP/6/,MSG(1)/10H(9X,      '/,TERM/3H')/
      CALL READMS(13,TXT,190,NMSG)
      NW=1+LENGTH(13)
      TXT(NW)=TERM
      WRITE(LP,MSG)
      RETURN
      END
      OVERLAY(1,0)
      PROGRAM INPUT
C
C        PROGRAM INPUT PERFORMS THE FUNCTIONS OF INTERPRETING ALL USER
C        DATA, ACCESSING/LOADING/UPDATING THE DEFAULT FILE AND ACCESSING
C        THE HACS PHYSICAL PROPERTY FILE.  THE BASIC STRUCTURE OF ALL
C        HACS DATA DECKS IS AS FOLLOWS -
C              1.   RUN CONTROL OPTION CARD
C              2.   RUN TITLE CARD
C              3.   ASSESSMENT PATH CARD
C              4.   CHEMICAL RECOGNITION CODE CARD
C              5.   ONE OR MORE FIELD DATA CARDS
C              6.   DATA DECK SEPARATOR CARD (9999) OR END OF FILE CARD
C        WHERE THE SPECIFIC PROCESSING OF EACH TYPE OF DATA DECK IS
C        DETERMINED BY THE RUN CONTROL OPTION WHICH HAS BEEN SELECTED.
C
C        THE CONTENT AND FORMAT OF FIELD DATA CARDS PROCESSED BY HACS
C        ARE DEFINED BELOW -
C
C        IFLD   = INTEGER FIELD NUMBER (UP TO FOUR DIGITS IN C.C. 1 TO
C                 4).  VALUE MUST BE POSITIVE, AND A VALUE OF 9999
C                 TERMINATES FIELD DATA INPUT.
C        FVL    = FIELD VALUE, ENTERED IN C.C. 5 TO 19 IN FIXED POINT
C                 FORMAT.  ALL INTEGERS MUST BE RIGHT JUSTIFIED.
C                 REAL FIELD VALUES WITHOUT EXPONENT MAY BE LOCATED
C                 ANYWHERE IN FIELD IF DECIMAL POINT IS GIVEN.
C                 EXPONENTIAL NOTATION MAY BE USED, BUT EXPONENT
C                 FIELD MUST BE RIGHT JUSTIFIED.
C        TAG    = UNIT LABEL, UP TO EIGHT CHARACTERS LEFT JUSTIFIED IN
C                 C.C. 20 TO 27.  APPLIES TO FIELD VALUE FVL, AND ALSO
C                 TO MIN AND MAX VALUES IF GIVEN.  IF THE UNIT FIELD
C                 IS BLANK, DIMENSIONS OF INPUT VALUES ARE ASSUMED TO
C                 BE CONSISTENT WITH PRE-DEFINED UNITS USED IN
C                 HACS INTERNAL COMPUTATIONS.
C        IR     = FLAG FOR INTEGER (0) OR REAL (1) FIELD VALUES IN C.C.
C                 28.  INPUT VALUES ARE ALLOWED ONLY DURING CREATION
C                 OF DEFAULT FILE, AND IN ORDER TO CHANGE THIS VALUE
C                 THE ENTIRE DEFAULT FILE MUST BE RE-LOADED.  NOTE
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C                 THAT CALLS TO SAVE AND RECALL ROUTINES ARE CODED
C                 DEPENDING ON IR, SO CHANGES IN THIS VALUE MAY ALSO
C                 REQUIRE CODE CHANGES.  (REFER TO ERROR CONDITIONS
C                 IN SAVE/RECALL.)
C        MM     = INDICATOR IN C.C. 29 USED TO CONTROL INPUT OF RANGE
C                 VALUES AS FOLLOWS -
C                       0 = NEITHER VALUE ENTERED
C                       1 = ONLY MINIMUM VALUE ENTERED IN C.C. 30 TO 44
C                       2 = ONLY MAXIMUM VALUE ENTERED IN C.C. 45 TO 59
C                       3 = BOTH MINIMUM AND MAXIMUM VALUES ENTERED
C                 WHEN LOADING THE DEFAULT FILE, BOTH MIN AND MAX
C                 VALUES MUST BE GIVEN AND MM MUST BE 3.
C        FMN    = MINIMUM FIELD VALUE, ENTERED IN C.C. 30 TO 44 IN
C                 FIXED POINT FORMAT (RIGHT JUSTIFIED).  VALUE IS
C                 READ IF MM IS 1 OR 3, AND CONVERTED DEPENDING ON
C                 INPUT OF UNIT LABEL, TAG.  SEE ALSO FVL ABOVE.
C        FMX    = MAXIMUM FIELD VALUE, ENTERED IN C.C. 45 TO 59 IN
C                 FIXED POINT FORMAT (RIGHT JUSTIFIED).  VALUE IS
C                 READ IF MM IS 2 OR 3, AND CONVERTED DEPENDING ON
C                 INPUT OF UNIT LABEL, TAG.  SEE ALSO FVL ABOVE.
C        ITP    = INTEGER SPECIFICATION IN C.C. 60-61, RIGHT JUSTIFIED,
C                 FOR TYPE OF PHYSICAL QUANTITY (USED TO CONTROL UNIT
C                 CONVERSION AND DISPLAY)
C        IN     = UP TO 12 CHARACTER FIELD NAME, LEFT JUSTIFIED IN C.C.
C                 62 TO 73, USED TO IDENTIFY OUTPUT
C        ---    = C.C. 74 TO 80 ARE NOT USED FOR INPUT DATA FIELDS
C                 EXCEPT THAT THE CORRESPONDENCE TO PROPERTY FILE
C                 FIELDS HAS BEEN GIVEN ON DEFAULT CARDS.  ANY OTHER
C                 SEQUENCE OR IDENTIFICATION INFORMATION MAY BE
C                 ENTERED IF DESIRED.
C
C        THE CONTENT OF THE HACS DEFAULT FILE IS DEFINED BY THE
C        SEQUENCE IN WHICH DATA CARDS ARE READ DURING THE CREATE
C        DEFAULT FILE OPTION.  CONSECUTIVE ARRAY POSITIONS ARE LOADED
C        SEQUENTIALLY.  THE ONLY FIXED DEFINITION IS THAT LIST(1,1)
C        IS RESERVED FOR FIELD 1001, CHEMICAL RECOGNITION CODE.
C
C        CNT    = COUNT OF FIELD DATA CARDS READ BY SUBROUTINE BASIC,
C                 USED TO ABORT HACS RUN IF DEFAULT FILE IS TO BE
C                 CREATED OR UPDATED BUT NO CARDS ARE READ
C        CR     = INTEGER FORTRAN UNIT NUMBER FOR CARD READER
C        FBLNK  = DATA WORD SET TO ALL BLANKS USED TO INITIALIZE LABELS
C        I      = DUMMY SUBSCRIPT, ARRAY INDEX
C        IARG   = ARRAY FOR READING USER OPTIONS FOR HACS STATE FILE
C                 DISPLAYS
C        IBLNK  = DATA WORD SET TO ALL BLANKS FOR TESTING CHEMICAL
C                 RECOGNITION CODE
C        IERR   = ERROR INDICATOR (=1), OTHERWISE 0.  USED TO ABORT
C                 RUN IF ERROR OCCURS WHILE READING DEFAULT DATA
C        IFLD   = FIELD NUMBER ON RECOGNITION CODE CARD, MUST BE 1001
C        IN     = ARRAY USED FOR READING LABELS ON USER DATA CARDS
C        ISW    = ERROR STATUS INDICATOR RETURNED BY PATH CHECK ROUTINE
C        IX     = TEMPORARY VARIABLE USED TO UPDATE SOURCE CODE OF
C                 RECOGNITION CODE IN STATE FILE
C        J      = DUMMY SUBSCRIPT OR ARRAY INDEX
C        K      = SUBSCRIPT USED IN STORING FILE DISPLAY OPTIONS
C        L      = SUM OF FILE DISPLAY OPTION VALUES ENTERED BY USER,
C                 USED TO GENERATE AUDIT ONLY IF ONE OR MORE OPTIONS
C                 WERE SELECTED
C        OPLST  = ARRAY CONTAINING THE FIRST FOUR CHARACTERS OF EACH
C                 VALID RUN CONTROL OPTION
C
C        COMMON VARIABLES USED - EOF,ICD,IDFLT,IPRAC,IVAL,LBL,LIST,
C                                LP,LSTCN,MNF,MNI,MODEL,MSG,MSYS,NF,NI,
C                                NOP,PTLST,SAVE,STATE,STCON,SVCON,TITLE,
C                                UPTH
C
C        SUBROUTINES REQUIRED  - ACCESS,BASIC,IFEOF,LSTFL,PAGER,PROP,
C                                PTHCK,RNTIO,TRACE
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
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C                               CAMBRIDGE, MASS., 02140
C                               TEL. 617-864-5770  EXT. 2813
C        DATE   - 12 FEBRUARY 1976
C
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1             NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER       UPTH
      REAL          MSG
      DIMENSION     STATE(2489)
      EQUIVALENCE   (STATE(1),MSG(1))
C
     0COMMON/CNTRL/EOFF,ICD,IDFLT,LBL(4),LSTCN(3,3),MODEL(15),NOP,
     1             STCON,SVCON
      INTEGER       EOFF,STCON,SVCON
      REAL          LBL
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
C
      COMMON/NAME/PTLST(30),SOURC(7)
      INTEGER       PTLST
C
C
      COMMON/PXFER/BUFF(15),K1,SNCOD
      INTEGER BUFF,SNCOD
      DIMENSION IARG(6),IN(4),OPLST(5)
      INTEGER TAGX
      LOGICAL ENTR,NAME
      LOGICAL QUEST
      LOGICAL YESNO
      LOGICAL INTEGR
      INTEGER    CNT,CR,OPLST
      INTEGER SCLST(28)
      INTEGER EXIT
      DATA EXIT/4HEXIT/
     0DATA (SCLST(I),I=1,28)/3HA B,3HA C,5HA B C,5HA D E,7HA D F G,
     1      9HA D E F G,3HA H,5HA I J,7HA H I J,5HA K L,7HA K M N,
     2      9HA K L M N,3HA O,3HA P,5HA P Q,7HA P R S,9HA P Q R S,
     3      3HA T,5HA T U,5HA V W,9HA T U V W,3HA X,5HA X Y,1HZ,2HII,
     4      2HRR,4HRR C,2HSS/
      DATA       CR/60/,FBLNK/10H          /,IBLNK/4H    /
     0DATA (OPLST(I),I=1,5)/8HRUN     ,8HRERUN   ,8HCONTINUE,
     1  8HEND     ,8H        /
C
C
C--------INITIALIZE
      CALL TRACE(0,1,0)
C
C--------RETURN HERE TO READ NEXT CONTROL CARD. TERMINATE ON END OF FILE
   10 NOP=0
      WRITE(LP,2000)
 20000FORMAT(32H ENTER RUN REQUEST, OPTIONS ARE ,
     1  24H(RUN/RERUN/CONTINUE/END))
      IF(.NOT.ENTR(0)) GO TO 10
      IF(.NOT.NAME(TAGX)) GO TO 10
      IF(TAGX.EQ.OPLST(4)) GO TO 430
C
C--------SEARCH LIST OF FIRST FOUR CHARACTERS OF CONTROL OPTIONS
   11 DO 20 NOP=1,3
      IF(TAGX.EQ.OPLST(NOP)) GO TO 21
   20 CONTINUE
C
C--------TERMINATE ON INVALID CONTROL CARD
      WRITE(LP,2010)
 2010 FORMAT(26H WHAT? (RUN REQUEST ERROR))
      GO TO 10
   21 DO 22 I=1,6
   22 IARG(I)=0
```

```
      GO TO 60
C
   30 CALL PAGER(3)
      WRITE(LP,1020)
      STOP
C
C--------READ TITLE CARD AND STORE FOR OUTPUT PAGE HEADING
   40 CONTINUE
      GO TO 60
C
C--------TERMINATE ON UNEXPECTED END OF FILE
   50 CALL PAGER(3)
      WRITE(LP,1030)
      GO TO 30
C
C--------BRANCH ON OPERATION CONTROL FLAG TO INITIALIZE STATE FILE
   60 GO TO(70,90,120,130,70),NOP
C
   70 IF(STCON.EQ.2) GO TO 150
   80 IF(SVCON.EQ.2) GO TO 100
      CALL ACCESS(STATE,IDFLT,0,STCON)
      GO TO 150
C
   90 IF(SVCON.GT.1) GO TO 100
      CALL ACCESS(SAVE,IDFLT,0,SVCON)
  100 DO 110 I=1,2489
  110 STATE(I)=SAVE(I)
      STCON=SVCON
      GO TO 150
C
  120 IF(STCON.LE.1) GO TO 80
      GO TO 150
C
  130 STCON=1
      SVCON=1
      NF=0
      NI=0
      DO 140 I=1,10
  140 MSG(I)=FBLNK
C
C--------START NEW PAGE AND WRITE FILE INITIALIZATION MESSAGE
  150 CALL PAGER(0)
C     CALL PAGER(5)
C     WRITE(LP,1040) LBL(STCON),MSG
C
C--------DECODE FILE LIST OPTIONS AND STORE IN LSTCN FOR USE IN
C        SUBROUTINE LSTFL.
      IERR=0
      L=0
      K=0
      DO 190 I=1,3
      DO 160 J=2,3
      K=K+1
      L=L+IARG(K)
  160 LSTCN(I,J)=IARG(K)
C
C--------OVERRIDE ANY USER INPUT ERRORS, BUT SET ERROR FLAG TO PRODUCE
C        AUDIT MESSAGE.
      IF(LSTCN(I,2).LE.MSYS) GO TO 180
  170 IERR=1
      LSTCN(I,1)=0
      GO TO 190
  180 IF(LSTCN(I,2).LT.0) GO TO 170
      IF(LSTCN(I,3).LT.0) GO TO 170
      IF(LSTCN(I,3).GT.1) GO TO 170
      LSTCN(I,1)=LSTCN(I,2)+LSTCN(I,3)
      IF(LSTCN(I,1).GT.0) LSTCN(I,1)=1
  190 CONTINUE
C
C--------DISPLAY STATE FILE AFTER INITIALIZATION IF OPTION SELECTED,
C        THEN PUT USER TITLE IN STATE FILE AND WRITE HEADER FOR LISTING
C        OF USER INPUT DATA
```

```
      CALL LSTFL(1)
      DO 200 I=1,10
  200 MSG(I)=TITLE(I)
      GO TO 500
C
C--------READ PATH CODE INPUT CARD.  TERMINATE IF INSTEAD GET END OF
C        FILE, OTHERWISE AUDIT INPUT THEN VALIDATE.  RUN IS TERMINATED
C        UNLESS USER INPUT PATH CODES, FOR ALL OPERATIONS, SATISFY ALL
C        VALIDATION TESTS IN SUBROUTINE PATH CHECK.
  212 WRITE(LP,2020)
 2020 FORMAT(52H ENTER ASSESSMENT MODEL LETTER CODES (A-Z/II/RR/SS):)
      IF(.NOT.ENTR(0)) GO TO 610
      IF(.NOT.QUEST(0)) GO TO 620
C---------USER TYPED ?, PRODUCE SCENARIO TABLE
C          WITH HEADER AND FOOTNOTES
      CALL SNMSG(29)
      WRITE(LP,6005) ICD
      CALL INIT(ITMP,28,1,1)
      DO 600 I=1,28
      ITMP=ITST(SNCOD,I)
      IF(ITMP.EQ.0) GO TO 600
      WRITE(LP,6010) SCLST(I)
      CALL SNMSG(I)
  600 CONTINUE
      WRITE(LP,6020)
      CALL SNMSG(30)
      CALL SNMSG(31)
      WRITE(LP,6020)
      ISW=1
      GO TO 700
 60050FORMAT (/9X,35HSCENARIOS APPROPRIATE FOR CHEMICAL ,A3,22H ARE DESC
     1RIBED BELOW -//)
 6010 FORMAT (/5X,A10/)
 6020 FORMAT (1X)
C---------USER TYPED (CR), DISPLAY CURRENT MODELS
  610 WRITE(LP,6030) (BUFF(I),I=1,K1)
      ISW=1
      GO TO 700
 6030 FORMAT (9X,43HAPPROPRIATE HAZARD ASSESSMENT MODELS ARE : ,15A3)
C---------USER TYPED MODEL INPUT
  620 CONTINUE
      DO 213 I=1,15
      UPTH(I)=IBLNK
      IF(.NOT.NAME(TAGX)) GO TO 213
      UPTH(I)=TAGX
  213 CONTINUE
  211 CALL PAGER(1)
      WRITE(LP,1110) (UPTH(I),I=1,15)
      CALL PTHCK(UPTH,PTLST,MODEL,ISW)
      IF(ISW.EQ.0) GO TO 700
C
C--------ERROR RETURNS FOR INVALID PATH CODES
      CALL PAGER(1)
      GO TO(220,230,240,250),ISW
C
  220 WRITE(LP,1120)
      GO TO 700
  230 WRITE(LP,1130)
      GO TO 700
  240 WRITE(LP,1140)
      GO TO 700
  250 WRITE(LP,1150)
C
C--------SECTION TO PRODUCE MODEL TEXT DESCRIPTIONS
  700 CALL PAGER(2)
      WRITE(LP,7000)
      IF(.NOT.YESNO(0)) GO TO 750
      CALL PAGER(2)
      WRITE(LP,7010)
  710 IF(.NOT.ENTR(0)) GO TO 730
      IF(QUEST(0)) GO TO 730
      IF(.NOT.NAME(TAGX)) GO TO 730
```

```
      IF(TAGX.EQ.EXIT) GO TO 750
      DO 720 I=1,29
      IF(TAGX.NE.PTLST(I)) GO TO 720
      CALL MODEXP(I)
      GO TO 740
  720 CONTINUE
      CALL PAGER(2)
      WRITE(LP,7020) TAGX
  730 CALL PAGER(2)
      WRITE(LP,7030)
  740 CALL PAGER(3)
      WRITE(LP,7040)
      GO TO 710
  750 IF(ISW.EQ.0) GO TO 430
      GO TO 212
 7000 FORMAT (/40H DO YOU NEED DESCRIPTIONS OF THE MODELS?)
 7010 FORMAT (/20H ENTER MODEL LETTER:)
 7020 FORMAT (/1X,A10,11H IS INVALID)
 7030 FORMAT (/45H VALID LETTER CODES ARE A TO Z, II, RR, OR SS)
 7040 FORMAT (/21H TYPE MODEL LETTER OR/27H TYPE EXIT TO CANCEL REPORT)
C
C--------READ CHEMICAL RECOGNITION CODE.  TERMINATE IF INSTEAD GET END
C        OF FILE, OTHERWISE AUDIT INPUT THEN STORE.  VALIDATION OCCURS
C        WHEN PROPERTY FILE IS ACCESSED.
  500 CONTINUE
  510 WRITE(LP,520)
  520 FORMAT (36H ENTER OUTPUT UNITS SELECTION (0-4):)
      IF(.NOT.ENTR(0)) GO TO 530
      IF(.NOT.QUEST(0)) GO TO 540
C---------USER TYPED ?
      CALL PAGER(8)
      WRITE(LP,5000)
      GO TO 510
 5000 FORMAT (/5X,27HTHE AVAILABLE OPTIONS ARE -/5X,16H0 FOR ALL UNITS,/
     1 5X,16H1 FOR CGS UNITS,/5X,15H2 FOR SI UNITS,/5X,24H3 FOR ENGLISH
     2UNITS, AND/5X,17H4 FOR MIXED UNITS/)
C---------USER TYPED (CR)
  530 CALL PAGER(3)
      WRITE(LP,5010) ICVSL
      GO TO 510
 5010 FORMAT (/5X,21HCURRENT SELECTION IS ,I1/)
C---------USER TYPED VALUE
  540 IF(.NOT.INTEGR(ICVSL)) GO TO 510
      NOFF=0
      IPRAC=1
      IPRRP=0
  260 WRITE(LP,2030)
 2030 FORMAT(33H ENTER CHEMICAL RECOGNITION CODE:)
      IF(.NOT.ENTR(0)) GO TO 262
      IF(.NOT.QUEST(0)) GO TO 264
C---------USER TYPED ?
      CALL PAGER(7)
      WRITE(LP,2060)
      GO TO 260
 2060 FORMAT (/5X,47HTHE CHEMICAL RECOGNITION CODE IS A THREE-LETTER/5X,
     1 47HALPHABETIC CODE USED TO SELECT THE CHEMICAL FOR/5X,48HHAZARD A
     2SSESSMENT.  REFER TO CHRIS MANUAL II FOR/5X,50HCROSS-REFERENCE LIS
     3TS OF CHEMICAL NAMES, SYNONYMS,/5X,22HAND RECOGNITION CODES./)
C---------USER TYPED (CR)
  262 CALL PAGER(3)
      WRITE(LP,2070) ICD
      GO TO 260
 2070 FORMAT (/5X,15HCURRENT CODE = ,A3/)
C---------USER TYPED CODE
  264 IF(.NOT.NAME(ICD)) GO TO 260
      IFLD=1001
  261 CALL PAGER(1)
C
C--------ERROR IF FIELD NUMBER IS NOT 1001, OR RECOGNITION CODE IS BLANK
      IF(IFLD.EQ.1001) GO TO 270
      CALL PAGER(1)
      WRITE(LP,1180)
```

```
      GO TO 30
  270 IF(ICD.NE.IBLNK) GO TO 280
      CALL PAGER(1)
      WRITE(LP,1190)
      GO TO 30
C
C---------STORE RECOGNITION CODE IN STATE FILE
  280 IF(NOP.NE.4) GO TO 310
      LIST(1,1)=1001
      LIST(1,2)=0461
      DO 290 I=1,3
      J=I+2
  290 LIST(1,J)=IN(I)
      LIST(1,6)=1
      NI=1
      IVAL(1,3)=0
      IVAL(1,2)=0
  300 IVAL(1,1)=ICD
      GO TO 320
  310 IX=LIST(1,2)/10
      LIST(1,2)=10*IX+1
      IF(NOP.NE.5) LIST(1,2)=LIST(1,2)+4
      GO TO 300
C
C---------READ BASIC FIELD DATA CARDS, THEN BRANCH ON NOP
  320 CONTINUE
      GO TO(330,340,350,355,360),NOP
C---------RUN
  330 STCON=3
      GO TO 370
C---------RE-RUN
  340 STCON=3
      GO TO 390
C---------CONTINUE
  350 IF(STCON.LT.3) STCON=3
      GO TO 390
C---------LOAD DEFAULT
  355 CALL PAGER(3)
      WRITE(LP,1220) NF,MNF,NI,MNI
C---------UPDATE DEFAULT
  360 IF(CNT.EQ.0) GO TO 410
      IF(IERR.EQ.1) GO TO 410
      STCON=2
      CALL ACCESS(STATE,IDFLT,1,STCON)
      CALL PAGER(5)
      WRITE(LP,1200)
  370 DO 380 I=1,2489
  380 SAVE(I)=STATE(I)
      SVCON=STCON
C---------AUDIT RUN TIME OPTIONS SELECTED
  390 CONTINUE
      CALL LSTFL(2)
      IF(NOP.GT.3) GO TO 400
      INDXX=1
      IF(IPRAC.NE.0) CALL PROP(INDXX)
      IF(INDXX.EQ.1) GO TO 212
      GO TO 260
  400 IF(EOFF.EQ.0) GO TO 10
      GO TO 420
  410 CALL PAGER(3)
      WRITE(LP,1210)
  420 NOP=0
      GO TO 430
C
 1000 FORMAT (4A4,3X,3(I1,1X,I1,7X))
 1010 FORMAT (//5X,30H*****UNRECOGNIZED CONTROL CARD/5X,4A4)
 1020 FORMAT (//5X,19H*****RUN TERMINATED)
 1025 FORMAT (10A8)
 1030 FORMAT (//5X,39H*****UNEXPECTED END OF FILE ENCOUNTERED)
 10400FORMAT (//5X,33HHACS STATE FILE INITIALIZED WITH ,A8,29H VALUES, F
     1ILE LABEL FOLLOWS -/10X,10A8/)
 1050 FORMAT (//5X,37HLISTING OF USER INPUT CARDS FOLLOWS -/5X,37(1H-)/)
```

```
1060 FORMAT (6X,4A4)
1070 FORMAT (10X,22H(FILE DISPLAY OPTIONS),5X,3(I1,1X,I1,7X))
1080 FORMAT (10X,41H*****WARNING - INVALID OPTIONS SUPPRESSED)
1090 FORMAT (6X,10A8)
1100 FORMAT (15A4)
1110 FORMAT (6X,15A4)
1120 FORMAT (5X,50H*****INPUT CONTAINS UNRECOGNIZABLE RATE MODEL CODE)
1130 FORMAT (5X,31H*****RATE MODEL CODES NOT GIVEN)
1140 FORMAT (5X,51H*****MODEL CODES NOT IN CORRECT ASSESSMENT SEQUENCE)
1150 FORMAT (5X,42H*****RATE MODEL CODES MISSING IN USER LIST)
1160 FORMAT (I4,A4,53X,3A4)
1170 FORMAT (6X,I4,A4,53X,3A4)
11800FORMAT (5X,60H*****FIELD NUMBER MUST BE 1001 FOR CHEMICAL RECOGNIT
    1ION CODE)
1190 FORMAT (5X,38H*****CHEMICAL RECOGNITION CODE MISSING)
1200 FORMAT (//5X,47HUPDATE OF HACS DEFAULT FILE HAS BEEN COMPLETED.//)
12100FORMAT (//5X,66H*****UPDATE OF HACS DEFAULT FILE HAS BEEN SUPPRESS
    1ED DUE TO ERRORS)
12200FORMAT (/5X,32HDEFAULT FILE STORAGE UTILIZATION/10X,I5,22H REAL FI
    1ELDS DEFINED, ,I8,10H ALLOCATED/10X,I5,25H INTEGER FIELDS DEFINED,
    2 ,I5,10H ALLOCATED)
  430 CALL TRACE(1,1,0)
      END
      SUBROUTINE ACCESS(ARRAY,UNIT,ISW,CNT)
C
C        SUBROUTINE ACCESS IS A UTILITY ROUTINE PROVIDED TO READ OR
C        WRITE HACS DEFAULT FILE VALUES ON PERIPHERAL STORAGE DEPENDING
C        ON THE OPTION SWITCH ISW.  NOTE THAT THE LENGTH OF THE HACS
C        DEFAULT FILE IS EXPLICITLY REQUIRED IN THIS ROUTINE TO
C        SPECIFY THE LENGTH OF THE I/O ARRAYS.
C
C        ARRAY  = HACS DATA FILE (STATE OR SAVE) INTO OR FROM WHICH
C                      DEFAULT VALUES ARE LOADED
C        CNT    = HACS FILE CONTROL VARIABLE SET TO 2 FOR FILE
C                      INITIALIZED TO DEFAULT VALUES
C        ISW    = OPTION SWITCH SET IN CALLING PROGRAM TO READ (0) OR
C                      WRITE (1) DEFAULT VALUES
C        J      = LOOP INDEX
C        UNIT   = FORTRAN UNIT NUMBER FOR PERIPHERAL STORAGE OF DEFAULT
C                      FILE VALUES
C
C        COMMON VARIABLES USED - NONE
C
C        SUBROUTINES REQUIRED  - NONE
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 18 NOVEMBER 1975
C
C
      DIMENSION    ARRAY(1)
      INTEGER      CNT,UNIT
C
C
C--------BRANCH ON OPTION SWITCH TO READ OR WRITE DEFAULT FILE.  TO
C        READ, COPY ALL DEFAULT VALUES TO ARGUMENT ARRAY AND SET FILE
C        CONTROL VARIABLE TO 2 FOR DEFAULT VALUES.
      IF(ISW.EQ.1) GO TO 20
      REWIND UNIT
      READ(UNIT) (ARRAY(J),J=1,2489)
      CNT=2
      RETURN
C
C--------UPDATE DEFAULT FILE STORED ON PERIPHERAL FILE
   20 REWIND UNIT
      WRITE(UNIT) (ARRAY(J),J=1,2489)
      RETURN
C
      END
      SUBROUTINE BASIC(NOP,IERR,EOFF,CNT)
```

```
C
C       SUBROUTINE BASIC READS, VALIDATES AND STORES INPUT FIELD DATA
C       CARDS IN THE HACS STATE FILE UNDER CONTROL OF THE ARGUMENT
C       NOP WHICH HAS VALUES ON INPUT AS FOLLOWS -
C             1     RUN OPTION, FIELD CARDS GIVE USER VALUES
C             2     RE-RUN OPTION, FIELD CARDS GIVE USER VALUES
C             3     CONTINUE OPTION, FIELD CARDS GIVE USER VALUES
C             4     LOAD DEFAULT OPTION, FIELD CARDS GIVE DEFAULT VALUES
C             5     UPDATE DEFAULT, FIELD CARDS GIVE DEFAULT VALUES
C
C       THE ROUTINE PROCESSES ALL FIELD DATA CARDS (EXCEPT FOR FIELD
C       1001 GIVING THE CHEMICAL RECOGNITION CODE) UNTIL EITHER A
C       FIELD 9999 CARD OR AN END OF FILE IS ENCOUNTERED.  ON RETURN,
C       CNT GIVES THE COUNT OF FIELD DATA CARDS READ, AND IERR IS 0 IF
C       NO ERRORS WERE IDENTIFIED.  IERR IS SET TO ONE IF AT LEAST
C       ONE ERROR WAS DETECTED.  ON RETURN, THE INDICATOR EOF IS SET TO
C       -1   IF AN END OF FILE WAS ENCOUNTERED, 0 OTHERWISE.  AN OUTPUT
C       LISTING OF EACH DATA CARD IS PRODUCED, FOLLOWED BY ERROR
C       MESSAGES AND/OR FIELD VALUE CONVERSIONS, IF ANY.  THE GENERAL
C       NATURE OF THE PROCESSING FOR EACH TYPE OF FIELD DATA CARD IS
C       INDICATED BELOW -
C
C       FOR NOP = 1, 2, OR 3
C             READ USER DATA CARD CONTAINING
C             IFLD,FVL,TAG ... WHERE -
C             1.  IFLD IS EITHER 9999 TO DENOTE END OF DATA, OR IFLD
C                       IS A PREVIOUSLY DEFINED FIELD NUMBER IN THE
C                       RANGE 2 TO 9998.
C             2.  TAG IS EITHER BLANK OR MATCHES AN ALLOWABLE UNIT
C                       LABEL FOR THE TYPE OF PHYSICAL QUANTITY DEFINED
C                       FOR FIELD IFLD.  IF TAG IS BLANK, THE VALUE FVL
C                       IS ASSUMED TO BE IN INTERNAL (CGS) UNITS AND IS
C                       NOT CONVERTED.  FIELD VALUE CONVERSIONS ARE
C                       APPLIED ONLY TO REAL FIELD VALUES, NOT INTEGERS
C             3.  IF THE VALUE FVL EXCEEDS THE NOMINAL BOUNDS DEFINED
C                       IN THE DEFAULT FILE, A WARNING MESSAGE IS
C                       GENERATED BUT THE VALUE IS STORED.  HOWEVER,
C                       FOR INTEGER FIELDS, IF THE VALUE GIVEN EXCEEDS
C                       AN INTERNAL LIMIT (ITOL), A FIELD JUSTIFICATION
C                       ERROR IS ASSUMED.  IN THIS CASE AN ERROR
C                       MESSAGE IS GENERATED AND THE FIELD VALUE IS
C                       NOT STORED.
C
C       FOR NOP = 4,     READ DEFAULT DATA CARD CONTAINING
C             IFLD,FVL,TAG,IVAR,MM,FMN,FMX,ITYP,(IN(I),I=1,3)...WHERE -
C             4.  IFLD IS EITHER 9999 TO DENOTE END OF DATA, OR IFLD
C                       IS A VALID FIELD NUMBER IN THE RANGE 2 TO 9998
C                       WHICH HAS NOT BEEN DEFINED BY A PREVIOUSLY
C                       ENTERED CARD.
C             5.  THE INDICATOR IVAR DEFINES THE INTERNAL STORAGE MODE
C                       FOR THE FIELD VALUE (0 FOR INTEGER, 1 FOR REAL)
C             6.  THE MIN/MAX SELECTOR MM MUST BE GIVEN AS 3 INDICATING
C                       THAT BOTH MINIMUM AND MAXIMUM NOMINAL ROUNDS
C                       ARE GIVEN FOR THE DEFAULT FILE DEFINITION.
C             7.  THE FIELD NAME, 1 TO 12 ALPHANUMERIC CHARACTERS READ
C                       INTO (IN(I),I=1,3), MUST NOT BE BLANK.
C             8.  THE TYPE OF PHYSICAL QUANTITY GIVEN BY ITYP MUST BE
C                       IN THE RANGE 1 TO MTYP, CORRESPONDING TO A
C                       PRE-DEFINED QUANTITY TYPE.
C             9.  SEE NOTE 2 ABOVE FOR VALIDATION OF THE UNIT LABEL
C                       TAG.  ALSO, FOR DEFAULT DATA, INPUT CONVERSIONS
C                       ARE APPLIED TO THE FIELD VALUE AND BOTH RANGE
C                       LIMITS FOR REAL FIELDS.  INPUT CONVERSIONS ARE
C                       NOT APPLIED TO INTEGER FIELDS.
C             10. IF THE FIELD VALUE FVL IS NOT WITHIN THE BOUNDS
C                       GIVEN, AN ERROR MESSAGE IS GENERATED, AND THE
C                       FIELD DEFINITION IS CANCELLED.  ALSO, FOR
C                       INTEGER FIELDS, THE VALUE AND RANGE LIMITS ARE
C                       COMPARED TO A LIMITING VALUE ITOL TO TEST FOR
C                       INCORRECT FIELD JUSTIFICATION.
C
C       FOR NOP = 5,     READ DEFAULT FILE UPDATE CARD CONTAINING
```

```
C              IFLD,FVL,TAG,MM,FMN,FMX,(IN(I),I=1,3) ... WHERE -
C              11. SEE NOTE 1 ABOVE.
C              12. THE MIN/MAX SELECTOR MM IS GIVEN AS
C                       0  NEITHER LIMIT UPDATED
C                       1  MINIMUM VALUE GIVEN
C                       2  MAXIMUM VALUE GIVEN
C                       3  NEW VALUES GIVEN FOR BOTH LIMITS
C              13. THE FIELD NAME (IN(I),I=1,3) IS REPLACED BY THE USER
C                       SPECIFIED LABEL IF NON-BLANK.  OTHERWISE THE
C                       NAME STORED IN THE DEFAULT FILE IS UNCHANGED.
C              14. SEE NOTE 2 ABOVE.  IN ADDITION, INPUT CONVERSIONS,
C                       IF ANY, ARE APPLIED TO ALL RANGE LIMITS GIVEN
C                       FOR REAL FIELDS (AS SPECIFIED BY MM)
C              15. SEE NOTE 10 ABOVE.  RANGE LIMIT TESTS USE UPDATED
C                       VALUES AS REQUESTED.
C
C
C         CNT    = ARGUMENT, INTEGER COUNT OF FIELD DATA CARDS READ
C                     EXCLUDING 9999 OR END OF FILE TERMINATORS
C         CR     = INTEGER FORTRAN UNIT NUMBER FOR CARD READER
C         D      = CONVERSION FACTOR FOR REAL FIELD OBTAINED FROM DATA
C                     ARRAY CONV
C         EOF    = ARGUMENT, RETURNED AS -1 IF AN END OF FILE WAS
C                       ENCOUNTERED WHEN READING FIELD DATA CARDS.  OTH
C                       WISE RETURNED AS 0.
C         FAC    = ARRAY OF CONVERSION FACTORS FOR TEMPERATURE FIELDS
C         FBLNK  = REAL DATA WORD CONTAINING ALL BLANKS USED TO TEST
C                     UNIT LABEL FIELD TAG
C         FMN    = LOWER LIMIT RANGE VALUE ENTERED ON USER INPUT CARD
C                     IN FIXED POINT FORMAT
C         FMX    = UPPER LIMIT RANGE VALUE ENTERED ON USER INPUT CARD
C                     IN FIXED POINT FORMAT
C         FVL    = FIELD VALUE ENTERED ON USER INPUT CARD IN FIXED
C                     POINT FORMAT
C         I      = DUMMY SUBSCRIPT
C         IBLNK  = INTEGER DATA WORD CONTAINING ALL BLANKS USED TO TEST
C                       FIELD NAME INPUT
C         IERR   = ARGUMENT, RETURNED AS 1 IF ONE OR MORE INPUT ERRORS
C                     WERE FOUND, 0 OTHERWISE.
C         IFLD   = FIELD NUMBER ENTERED ON USER INPUT CARD
C         ILN    = INDEX TO POSITION IN STATE FILE FIELD DEFINITION
C                     ARRAY CORRESPONDING TO FIELD IFLD.
C         IMN    = LOWER LIMIT RANGE VALUE FOR INTEGER FIELD, OBTAINED
C                     FROM DEFAULT FILE OR CONVERSION OF INPUT VALUE FMN
C         IMX    = UPPER LIMIT RANGE VALUE FOR INTEGER FIELD, OBTAINED
C                     FROM DEFAULT FILE OR CONVERSION OF INPUT VALUE FMX
C         IN     = ARRAY FOR STORAGE OF USER SPECIFIED FIELD NAME CON-
C                     TAINING UP TO 12 CHARACTERS STORED AS 3A4.
C         ISRC   = FIELD VALUE SOURCE CODE IN STATE FILE BEFORE USER
C                       FIELD TRANSACTION IS STORED
C         ISW    = CONTROL SWITCH SET TO 0 IF INPUT FOR FIELD NAME IS
C                     BLANK, 1 IF NON-BLANK, FOR HANDLING OPTIONAL CHANGE
C                     ON DEFAULT FILE UPDATE
C         ISYS   = INTEGER IN RANGE 1 TO MSYS DETERMINED BY MATCHING
C                     UNIT TAG TO PRE-DEFINED LABELS FOR THE PARTICULAR
C                     TYPE OF PHYSICAL QUANTITY.  IF TAG IS BLANK OR THE
C                     SAME AS INTERNAL HACS UNITS, ISYS IS COMPUTED AS 1
C                     AND CONVERSION ON INPUT IS SKIPPED.
C         ITOL   = INTEGER TOLERANCE LEVEL SET AS DATA VALUE FOR TESTING
C                     FIELD JUSTIFICATION OF INTEGER VALUES ON INPUT
C         ITYP   = TYPE OF PHYSICAL QUANTITY FOR INDIVIDUAL FIELD IN
C                     RANGE 1 TO MTYP
C         IVAR   = INTERNAL FIELD VALUE STORAGE MODE INDICATOR
C                     (0 FOR INTEGER, 1 FOR REAL)
C         IVL    = FIELD VALUE FOR INTEGER FIELD, OBTAINED FROM INPUT
C                     CARD BY CONVERSION OF FVL
C         IX     = INDEX TO POSITION IN FIELD VALUE DATA ARRAYS FVAL OR
C                     IVAL CORRESPONDING TO FIELD DEFINITION IN ARRAY LIST
C         J      = DUMMY SUBSCRIPT
C         JSYS   = INDEX TO CONVERSION FACTOR DATA ARRAY CORRESPONDING
C                     TO ISYS-1 WHERE ISYS INDEXES THE UNIT LABEL DATA
C         MM     = MIN/MAX SELECTOR USED TO SPECIFY WHICH RANGE VALUES
```

```
C                    HAVE BEEN ENTERED ON USER DATA CARD (0=NEITHER,
C                    1=MIN ONLY, 2=MAX ONLY, 3=BOTH MIN AND MAX)
C         NFLD   = TOTAL NUMBER OF FIELDS DEFINED IN HACS STATE FILE
C         NOP    = CONTROL SELECTOR DETERMINED FROM USER SPECIFIED
C                    PROCESSING OPTION
C         SEQ    = REAL VARIABLE USED TO READ AND DISPLAY CONTENTS OF
C                    SEQUENCE FIELD ON INPUT CARD
C         TAG    = FIELD ON USER INPUT CARD FOR UNIT LABEL IN A8 FORMAT
C
C         COMMON VARIABLES USED - CONV,FVAL,IVAL,LIST,LP,MNF,MNI,MSYS,
C                                 MTYP,NF,NI,UNIT
C
C         SUBROUTINES REQUIRED - IABS,IFEOF,IFIX,PAGER
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                              35/309A ACORN PARK
C                              CAMBRIDGE, MASS., 02140
C                              TEL. 617-864-5770  EXT. 2813
C         DATE   - 12 FEBRUARY 1976
C
C
     0COMMON/BASE/SAVE(2489),UPTH(15),MSG(10),MNF,MNI,
     1            NF,NI,LIST(275,6),FVAL(225,3),IVAL(50,3)
      INTEGER     UPTH
      REAL        MSG
      DIMENSION   STATE(2489)
      EQUIVALENCE (STATE(1),MSG(1))
C
      COMMON/CNVDT/CONV(3,47),MSYS,MTYP,UNIT(4,47)
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
C
      INTEGER   CNT,CR,EOFF
      DIMENSION FAC(3),IN(3)
      DATA      CR/60/,FBLNK/8H        /,IBLNK/4H    /,ITOL/10000/
      DATA      (FAC(I),I=1,3)/1.0,1.8,1.0/
C
C
C--------INITIALIZATION SECTION.  SET VARIABLE VALUES, THEN BRANCH ON
C         OPERATION FLAG TO PRINT HEADER FOR DATA INPUT LISTING
      CNT=0
      EOFF=0
      IERR=0
      NFLD=NF+NI
      CALL PAGER(3)
      GO TO(10,10,10,20,30),NOP
   10 WRITE(LP,1000)
      GO TO 40
   20 WRITE(LP,1010)
      GO TO 40
   30 WRITE(LP,1020)
C
C--------RETURN HERE TO READ EACH NEW USER INPUT CARD
   40 READ(CR,1030) IFLD,FVL,TAG,IVAR,MM,FMN,FMX,ITYP,(IN(I),I=1,3),SEQ
C
C--------TEST FOR TERMINATION.  RETURN ON END OF FILE OR END OF DATA
C         CARD.  OTHERWISE INCREMENT COUNT OF USER DATA CARDS READ.
      IF(EOF(CR))50,60
   50 EOFF=-1
      CALL PAGER(3)
      WRITE(LP,1040)
      RETURN
   60 IF(IFLD.NE.9999) GO TO 70
      CALL PAGER(3)
      WRITE(LP,1050)
      RETURN
   70 CNT=CNT+1
C
C--------LOOK UP FIELD NUMBER READ ON INPUT CARD IN HACS STATE FILE
      ILN=1
   80 ILN=ILN+1
```

```
      IF(ILN.GT.NFLD) GO TO 85
      IF(IFLD.EQ.LIST(ILN,1)) GO TO 130
      GO TO 80
   85 CONTINUE
C
C--------FIELD NUMBER WAS NOT FOUND IN HACS STATE FILE.  INDEX ILN
C          POINTS TO NEXT AVAILABLE SLOT IN FILE FOR ENTERING DEFAULT
C          DATA.  AN ERROR EXISTS FOR OTHER OPERATIONS.
      IF(NOP.EQ.4) GO TO 110
      CALL PAGER(1)
      WRITE(LP,1060) IFLD
   90 CALL PAGER(1)
      WRITE(LP,1070)
      IERR=1
      GO TO 40
C
C--------DISPLAY CONTENTS OF DATA CARD READ TO CREATE DEFAULT FILE
C          ENTRY.  USE EITHER INTEGER OR REAL (BY DEFAULT) FORMAT
  110 CALL PAGER(1)
      IF(IVAR.EQ.0) GO TO 120
      WRITE(LP,1080) IFLD,FVL,TAG,IVAR,MM,FMN,FMX,ITYP,(IN(I),I=1,3),SEQ
      GO TO 180
  120 IVL=IFIX(FVL)
      IMN=IFIX(FMN)
      IMX=IFIX(FMX)
      WRITE(LP,1090) IFLD,IVL,TAG,IVAR,MM,IMN,IMX,ITYP,(IN(I),I=1,3),SEQ
      GO TO 180
C
C--------FIELD NUMBER READ FROM INPUT MATCHED ENTRY IN STATE FILE.
C          ERROR CONDITION FOR ENTERING DEFAULT DATA, OTHERWISE UNCODE
C          INFORMATION IN STATE FILE AND AUDIT INPUT.
  130 IF(NOP.NE.4) GO TO 140
      CALL PAGER(1)
      WRITE(LP,1100) IFLD
      GO TO 90
  140 IVAR=LIST(ILN,2)/1000
      ISRC=1000*IVAR
      ITYP=(LIST(ILN,2)-ISRC)/10
      ISRC=LIST(ILN,2)-10*ITYP-ISRC
C
      IX=LIST(ILN,6)
      CALL PAGER(1)
      IF(NOP.NE.5) GO TO 160
      IF(IVAR.EQ.0) GO TO 150
      WRITE(LP,1110) IFLD,FVL,TAG,MM,FMN,FMX,(IN(I),I=1,3),SEQ
      GO TO 210
  150 IVL=IFIX(FVL)
      IMN=IFIX(FMN)
      IMX=IFIX(FMX)
      WRITE(LP,1120) IFLD,IVL,TAG,MM,IMN,IMX,(IN(I),I=1,3),SEQ
      GO TO 210
C
  160 IF(IVAR.EQ.0) GO TO 170
      FMN=FVAL(IX,2)
      FMX=FVAL(IX,3)
      WRITE(LP,1080) IFLD,FVL,TAG
      GO TO 280
  170 IVL=IFIX(FVL)
      IMN=IVAL(IX,2)
      IMX=IVAL(IX,3)
      WRITE(LP,1090) IFLD,IVL,TAG
      GO TO 280
C
C--------TEST FOR VALID FIELD NUMBER
  180 IF(IFLD.LT.1) GO TO 190
      IF(IFLD.LE.9998) GO TO 200
  190 CALL PAGER(1)
      WRITE(LP,1130)
      GO TO 90
C
C--------TEST FOR VALID STORAGE MODE INDICATOR.  NOTE THAT IF IVAR=0,
C          IVL, IMN AND IMX HAVE ALREADY BEEN OBTAINED FOR AUDIT.
```

```
  200 IF(IVAR.EQ.0) GO TO 210
      IF(IVAR.EQ.1) GO TO 210
      CALL PAGER(1)
      WRITE(LP,1140)
      GO TO 90
C
C--------TEST MINIMUM/MAXIMUM INPUT DATA SELECTOR
  210 IF(MM.LT.0) GO TO 220
      IF(MM.GT.3) GO TO 220
      IF(NOP.EQ.5) GO TO 230
      IF(MM.EQ.3) GO TO 230
  220 CALL PAGER(1)
      WRITE(LP,1150)
      GO TO 90
C
C--------TEST FOR NON-BLANK FIELD NAME (ISW=1).
  230 ISW=1
      DO 240 I=1,3
      IF(IN(I).NE.IBLNK) GO TO 250
  240 CONTINUE
      ISW=0
      IF(NOP.EQ.5) GO TO 290
      CALL PAGER(1)
      WRITE(LP,1160)
      GO TO 90
  250 IF(NOP.EQ.5) GO TO 290
C
C--------TEST TYPE CODE.  MUST BE IN RANGE OF DEFINED TYPES OF
C             PHYSICAL QUANTITIES.
      IF(ITYP.LT.1) GO TO 270
      IF(ITYP.LE.MTYP) GO TO 290
  270 CALL PAGER(1)
      WRITE(LP,1170) MTYP
      GO TO 90
C
C--------SET PARAMETERS FOR NOP = 1, 2 OR 3
  280 MM=0
      ISW=0
C
C--------VERIFY UNIT LABEL SPECIFICATION.  CONVERSION TO INTERNAL UNITS
C             IS REQUIRED UNLESS ISYS IS DETERMINED TO BE 1.
  290 ISYS=1
      IF(TAG.EQ.FBLNK) GO TO 310
  300 IF(TAG.EQ.UNIT(ISYS,ITYP)) GO TO 310
      ISYS=ISYS+1
      IF(ISYS.LE.MSYS) GO TO 300
      CALL PAGER(1)
      WRITE(LP,1180)
      GO TO 90
C
C
C--------SEPARATE PROCESSING FOR INTEGER AND REAL FIELDS
  310 IF(IVAR.EQ.0) GO TO 450
C
C
C--------CONVERT REAL FIELD VALUES IF NECESSARY
      IF(ISYS.EQ.1) GO TO 330
      JSYS=ISYS-1
      D=CONV(JSYS,ITYP)
      IF(ITYP.NE.6) GO TO 315
      FVL=(FVL-D)/FAC(JSYS)
      GO TO 316
  315 FVL=D*FVL
  316 CALL PAGER(1)
      IF(NOP.GT.3) GO TO 320
      WRITE(LP,1190) FVL,UNIT(1,ITYP)
      GO TO 330
  320 IF(ITYP.NE.6) GO TO 321
      FMN=(FMN-D)/FAC(JSYS)
      FMX=(FMX-D)/FAC(JSYS)
      GO TO 322
  321 FMN=D*FMN
```

```
      FMX=D*FMX
  322 WRITE(LP,1190) FVL,UNIT(1,ITYP),FMN,FMX
C
C--------FOR OPERATIONS TO CHANGE DEFAULT VALUES, RESTORE UNCHANGED
C         LIMITS FROM DEFAULT FILE
  330 IF(NOP.NE.5) GO TO 360
      IF(MM.NE.0) GO TO 350
      FMN=FVAL(IX,2)
  340 FMX=FVAL(IX,3)
      GO TO 360
  350 IF(MM.EQ.3) GO TO 360
      IF(MM.EQ.1) GO TO 340
      FMN=FVAL(IX,2)
C
C--------CHECK RANGE OF REAL VARIABLE
  360 IF(FVL.LT.FMN) GO TO 370
      IF(FVL.LE.FMX) GO TO 380
  370 CALL PAGER(1)
      WRITE(LP,1200) FMN,FMX,UNIT(1,ITYP)
      IF(NOP.GT.3) GO TO 90
C
C--------STORE REAL VALUES IN STATE FILE
  380 IF(NOP.EQ.4) GO TO 390
      IF(NOP.EQ.5) GO TO 410
      FVAL(IX,1)=FVL
      LIST(ILN,2)=LIST(ILN,2)-ISRC+5
      GO TO 40
  390 IF(NF.LT.MNF) GO TO 400
      CALL PAGER(1)
      WRITE(LP,1210) MNF
      GO TO 90
  400 NF=NF+1
      NFLD=NFLD+1
      IX=NF
      LIST(ILN,1)=IFLD
      LIST(ILN,2)=1001+10*ITYP
      LIST(ILN,6)=NF
      GO TO 420
  410 LIST(ILN,2)=LIST(ILN,2)-ISRC+1
  420 FVAL(IX,1)=FVL
      FVAL(IX,2)=FMN
      FVAL(IX,3)=FMX
  430 IF(ISW.EQ.0) GO TO 40
      DO 440 I=1,3
      J=I+2
  440 LIST(ILN,J)=IN(I)
      GO TO 40
C
C
C--------TEST FOR REQUESTED CONVERSION OF INTEGER FIELD VALUES
  450 IF(ISYS.EQ.1) GO TO 460
      CALL PAGER(1)
      WRITE(LP,1220)
C
C--------TEST FOR CORRECT FIELD JUSTIFICATION OF INTEGER VALUES
  460 IF(IABS(IVL).GT.ITOL) GO TO 470
      IF(NOP.LE.3) GO TO 480
      IF(IABS(IMN).GT.ITOL) GO TO 470
      IF(IABS(IMX).LE.ITOL) GO TO 480
  470 CALL PAGER(1)
      WRITE(LP,1230) ITOL
      GO TO 90
C
C--------COMPARE INTEGER FIELD VALUE TO NOMINAL RANGE LIMITS. FOR
C         OPERATIONS TO CHANGE DEFAULT VALUES, FIRST RESTORE UNCHANGED
C         LIMITS FROM DEFAULT FILE.
  480 IF(NOP.NE.5) GO TO 510
      IF(MM.NE.0) GO TO 500
      IMN=IVAL(IX,2)
  490 IMX=IVAL(IX,3)
      GO TO 510
  500 IF(MM.EQ.3) GO TO 510
```

```
      IF(MM.EQ.1) GO TO 490
      IMN=IVAL(IX,2)
C
C--------COMPARE TO NOMINAL LIMITS
  510 IF(IVL.LT.IMN) GO TO 520
      IF(IVL.LE.IMX) GO TO 530
  520 CALL PAGER(1)
      WRITE(LP,1240) IMN,IMX,UNIT(1,ITYP)
      IF(NOP.GT.3) GO TO 90
C
C--------STORE INTEGER VALUES IN STATE FILE
  530 IF(NOP.EQ.4) GO TO 540
      IF(NOP.EQ.5) GO TO 560
      IVAL(IX,1)=IVL
      LIST(ILN,2)=LIST(ILN,2)-ISRC+5
      GO TO 40
  540 IF(NI.LT.MNI) GO TO 550
      CALL PAGER(1)
      WRITE(LP,1250) MNI
      GO TO 90
  550 NI=NI+1
      NFLD=NFLD+1
      IX=NI
      LIST(ILN,1)=IFLD
      LIST(ILN,2)=1+10*ITYP
      LIST(ILN,6)=NI
      GO TO 570
  560 LIST(ILN,2)=LIST(ILN,2)-ISRC+1
  570 IVAL(IX,1)=IVL
      IVAL(IX,2)=IMN
      IVAL(IX,3)=IMX
      GO TO 430
C
 10000FORMAT (5X,5HFIELD/5X,31HNUMBER  FIELD VALUE        UNIT/5X,
     1   6(1H-),2X,15(1H-),2X,8(1H-))
 10100FORMAT (5X,5HFIELD,30X,8HI=0  MIN/5X,95HNUMBER  FIELD VALUE
     1 UNIT     R=1  MAX  NOMINAL MINIMUM  NOMINAL MAXIMUM  TYPE  FIELD N
     2AME,4X,7HCOMMENT/5X,6(1H-),2X,15(1H-),2X,8(1H-),2(2X,3(1H-)),
     3   2(2X,15(1H-)),2X,4(1H-),2X,12(1H-),2X,7(1H-))
 10200FORMAT (5X,5HFIELD,30X,8H     MIN/5X,95HNUMBER  FIELD VALUE
     1 UNIT          MAX  NOMINAL MINIMUM  NOMINAL MAXIMUM        FIELD N
     2AME,4X,7HCOMMENT/5X,6(1H-),2X,15(1H-),2X,8(1H-),2(2X,3(1H-)),
     3   2(2X,15(1H-)),2X,4(1H-),2X,12(1H-),2X,7(1H-))
 1030 FORMAT (I4,F15.0,A8,2I1,2F15.0,I2,3A4,A7)
 1040 FORMAT (5X,11HEND OF FILE//)
 1050 FORMAT (6X,4H9999//)
 1060 FORMAT (5X,39H*****ERROR - UNDEFINED FIELD NUMBER = (,I4,1H))
 1070 FORMAT (10X,21HINPUT DATA IS IGNORED)
 10800FORMAT (6X,I4,5X,G13.4,2X,A8,3X,I1,4X,I1,5X,G13.4,4X,G13.4,3X,
     1          I2,3X,3A4,2X,A7)
 10900FORMAT (6X,I4,8X,I10,2X,A8,3X,I1,4X,I1,8X,I10,7X,I10,3X,I2,3X,
     1          3A4,2X,A7)
 11000FORMAT (5X,48H*****ERROR - PREVIOUSLY DEFINED FIELD NUMBER = (,
     1      I4,1H))
 1110 FORMAT (6X,I4,5X,G13.4,2X,A8,8X,I1,5X,G13.4,4X,G13.4,8X,3A4,2X,A7)
 1120 FORMAT (6X,I4,8X,I10,2X,A8,8X,I1,8X,I10,7X,I10,8X,3A4,2X,A7)
 11300FORMAT (5X,65H*****ERROR - ILLEGAL FIELD NUMBER NOT IN RANGE 1 TO
     19998, OR 9999)
 11400FORMAT (5X,73H*****ERROR - STORAGE MODE INDICATOR NOT 0 FOR INTEGE
     1R OR 1 FOR REAL FIELD)
 1150 FORMAT (5X,44H*****ERROR - ILLEGAL MIN/MAX INDICATOR VALUE)
 1160 FORMAT (5X,34H*****ERROR - FIELD NAME IS MISSING)
 11700FORMAT (5X,57H*****ERROR - TYPE OF PHYSICAL QUANTITY NOT IN RANGE
     11 TO ,I2)
 1180 FORMAT (5X,51H*****ERROR - UNIT LABEL INCONSISTENT WITH TYPE CODE)
 1190 FORMAT (11X,1H=,4X,G13.4,2X,A8,14X,G13.4,4X,G13.4)
 12000FORMAT (5X,46H*****WARNING/ERROR - FIELD VALUE NOT IN RANGE ,
     1          G13.4,4H TO ,G13.4,1X,A8)
 12100FORMAT (5X,60H*****ERROR - NUMBER OF REAL FIELDS DEFINED EXCEEDS L
     1IMIT OF ,I3)
 12200FORMAT (5X,64H*****WARNING - CONVERSION OF INTEGER FIELD VALUES NO
     1T APPLICABLE)
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```
12300FORMAT (5X,70H*****ERROR - INTEGERS MUST BE RIGHT JUSTIFIED, VALUE
    1 EXCEEDS LIMIT OF ,I10)
12400FORMAT (5X,46H*****WARNING/ERROR - FIELD VALUE NOT IN RANGE ,
    1I10,4H TO ,I10,1X,A8)
12500FORMAT (5X,63H*****ERROR - NUMBER OF INTEGER FIELDS DEFINED EXCEED
    1S LIMIT OF ,I3)
C
      END
      SUBROUTINE BNDCK(ISW,TEMP,ITEMP,NFTLO,NFTUP)
C
C        SUBROUTINE BOUND CHECK COMPARES THE REQUESTED TEMPERATURE TEMP
C        TO THE BOUNDS, IF ANY, DEFINED FOR A TEMPERATURE FUNCTION. THE
C        ARGUMENT ISW PROVIDES A CONTROL PARAMETER SO THAT THE
C        TEMPERATURE BOUNDS, DEFINED AS FIELDS NFTLO AND NFTUP IN THE
C        STATE FILE, ARE RETRIEVED ONLY ONCE AND STORED FOR LATER USE
C        IN COMMON AS THE VALUES TLO AND TUP, HAVING SOURCE CODES ILO
C        AND IUP, RESPECTIVELY.  A MESSAGE IS GENERATED IF THE REQUESTED
C        TEMPERATURE EXCEEDS A BOUNDING VALUE.  THE TEMPERATURE VALUE
C        IS SET TO THE LIMIT ONLY IF THE EXCEEDED BOUND IS GIVEN WITH
C        A SOURCE CODE OF GREATER THAN DEFAULT.  IF ADJUSTED THE
C        TEMPERATURE SOURCE CODE IS CHANGED TO NOT EXCEED AN ESTIMATED
C        PROPERTY VALUE.  THE SOURCE CODE FOR THE COMPUTED FUNCTION
C        VALUE IS OBTAINED AS THE MINIMUM OF ALL SOURCE CODES ON THE
C        RIGHT-HAND SIDE OF THE TEMPERATURE FUNCTION EQUATION.  THUS
C        IF ANY DEFAULT VALUES HAVE BEEN USED, THE TEMPERATURE FUNCTION
C        VALUE WILL BE COMPUTED FOR DISPLAY, BUT THE PRIORITY STRUCTURE
C        WILL NOT PERMIT THE COMPUTED VALUE TO BE SAVED IN THE STATE
C        FILE.  FINALLY, THE ROUTINE WRITES THE VALUE OF TEMPERATURE
C        TO BE USED IN THE COMPUTATION.
C
C        IERR   = DATA BASE RECALL ERROR INDICATOR, NOT USED.  ERRORS,
C                     IF ANY, ALSO RETURN SOURCE CODE OF ZERO WHICH IS
C                     USED INSTEAD OF SEPARATE ERROR PROCESSING
C        ISW    = ARGUMENT, SET TO 1 ON FIRST CALL TO FORCE RETRIEVAL
C                     OF TEMPERATURE BOUNDS FROM STATE FILE AND STORAGE
C                     IN COMMON.  SET TO 2 ON SECOND CALL TO USE VALUES
C                     PREVIOUSLY STORED IN COMMON.
C        ITEMP  = ARGUMENT, SOURCE CODE ASSOCIATED WITH TEMPERATURE TO
C                     BE USED IN FUNCTION CALCULATION
C        NFTLO  = FIELD NUMBER IN STATE FILE FOR LOWER TEMPERATURE
C                     LIMIT (USED ONLY IF ISW=1)
C        NFTUP  = FIELD NUMBER IN STATE FILE FOR UPPER TEMPERATURE
C                     LIMIT (USED ONLY IF ISW=1)
C        TEMP   = ARGUMENT, TEMPERATURE AT WHICH FUNCTION IS TO BE
C                     COMPUTED
C
C        COMMON VARIABLES USED - ILO,IMN,IT,IUP,LP,NPRRP,T,TLO,TUP
C
C        SUBROUTINES REQUIRED  - FRCL,PAGER
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 1 APRIL 1976
C
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
C
      COMMON/TFUN/A,B,C,D,ILO,IMN,IT,IUP,T,TLO,TUP
C
C
C--------BRANCH ON ARGUMENT CONTROL SWITCH, AND RECALL TEMPERATURE
C        RANGE FOR FUNCTION ON FIRST TIME THROUGH.  NOTE THAT SOURCE
C        CODES ARE SAVED SEPARATELY AND ARE ZERO IF AN ERROR OCCURRED.
      IF(ISW.EQ.2) GO TO 10
      ILO=7
      CALL FRCL(NFTLO,TLO,ILO,IERR)
      IUP=7
      CALL FRCL(NFTUP,TUP,IUP,IERR)
```

```
C
C--------STORE REQUESTED TEMPERATURE FOR FUNCTION COMPUTATION
   10 T=TEMP
      IT=ITEMP
C
C--------COMPARE TEMPERATURE TO UPPER BOUND.  SET TO LIMIT IF EXCEEDED
C          AND UPPER BOUND IS GIVEN WITH HIGHER SOURCE CODE THAN DEFAULT.
      IF(T.LE.TUP) GO TO 40
      CALL PAGER(3)
      WRITE(LP,1000) T,TLO,TUP
      IF(IUP.LE.1) GO TO 30
      T=TUP
   20 CALL PAGER(2)
      WRITE(LP,1010)
C
C--------ADJUST SOURCE CODE OF TEMPERATURE WHEN VALUE HAS BEEN CHANGED.
      IF(IT.GT.2) IT=2
      GO TO 50
   30 CALL PAGER(2)
      WRITE(LP,1020)
      GO TO 50
C
C--------COMPARE TEMPERATURE TO LOWER BOUND.  SET TO LIMIT IF EXCEEDED
C          AND LOWER BOUND IS GIVEN WITH HIGHER SOURCE CODE THAN DEFAULT.
   40 IF(T.GE.TLO) GO TO 50
      CALL PAGER(3)
      WRITE(LP,1000) T,TLO,TUP
      IF(ILO.LE.1) GO TO 30
      T=TLO
      GO TO 20
C
C--------ASSIGN FUNCTION VALUE SOURCE CODE TO MINIMUM SOURCE CODE OF
C          VALUES ON RIGHT-HAND SIDE OF EQUATION
   50 IF(IT.GT.IMN) IT=IMN
C
C--------DISPLAY VALUE OF TEMPERATURE USED IN COMPUTATION
      IF(NPRRP.EQ.0) RETURN
      CALL PAGER(2)
      WRITE(LP,1030) T
      RETURN
C
 10000FORMAT (/ 5X,40H*****WARNING - REQUESTED TEMPERATURE OF ,G13.4/15X
     1, 20HIS NOT WITHIN RANGE ,G13.4,4H TO ,G13.4/)
 1010 FORMAT ( 10X,46HCOMPUTATION USES TEMPERATURE AT LIMIT OF RANGE/)
 10200FORMAT ( 10X,68HINSUFFICIENT DATA AVAILABLE - COMPUTATION USES REQ
     1UESTED TEMPERATURE/)
 10300FORMAT ( 10X,42HFUNCTION VALUE COMPUTED AT TEMPERATURE OF ,G13.4,
     1 14H DEG. C IS .../)
      END
      LOGICAL FUNCTION COEF(NFA,NFB,NFC,NFD)
C
C          FUNCTION COEF RETRIEVES UP TO FOUR TEMPERATURE FUNCTION
C          COEFFICIENTS FROM THE DATA BASE, AND RETURNS A LOGICAL VALUE
C          INDICATING WHETHER OR NOT THE COMPUTATION CAN PROCEED.  THE
C          ARGUMENTS DEFINE THE FIELD NUMBERS FOR THE COEFFICIENTS OR
C          ARE ZERO.  COEFFICIENTS, FOR NON-ZERO FIELD NUMBERS, ARE
C          RETRIEVED AND STORED IN A TO D.  IF AN ERROR IS ENCOUNTERED
C          DURING RECALL, OR IF AT LEAST ONE COEFFICIENT DOES NOT HAVE
C          A HIGHER SOURCE CODE THAN A DEFAULT VALUE, THE FUNCTION PRINTS
C          A MESSAGE AND RETURNS A VALUE OF .TRUE. SO THAT FURTHER
C          PROCESSING MAY BE SKIPPED.  ON RETURN, COEF IS SET .FALSE.
C          IF AT LEAST ONE NON-DEFAULT COEFFICIENT WAS FOUND.  HOWEVER,
C          IMN GIVES THE MINIMUM SOURCE CODE FOR ALL COEFFICIENTS AND
C          IS USED TO ASSIGN A SOURCE CODE TO THE COMPUTED FUNCTION VALUE.
C          THIS METHOD PERMITS THE COMPUTATION TO PROCEED FOR DISPLAY
C          PURPOSES IF COEFFICIENTS ARE PARTIALLY SPECIFIED, BUT
C          SUPPRESSES STORAGE OF THE RESULTING FUNCTION VALUE IN THE
C          STATE FILE.
C
C          COEF   = FUNCTION VALUE RETURNED .FALSE. IF RETRIEVED
C                     COEFFICIENTS CAN BE USED FOR COMPUTATION OF
C                     TEMPERATURE FUNCTION VALUE, .TRUE. OTHERWISE
```

```
C        IERR   = DATABASE RECALL ERROR INDICATOR SET TO ONE IF AN
C                    ERROR OCCURRED.
C        IMX    = HIGHEST SOURCE CODE FOR COEFFICIENTS REQUESTED
C        ISRC   = DUMMY ARGUMENT RETURNING SOURCE CODE FOR SINGLE
C                    FIELD VALUE RECALL USED TO OBTAIN MIN/MAX SOURCE
C                    CODES FOR MULTIPLE RECALLS
C        NFA    = FIELD NUMBER FOR COEFFICIENT TO BE STORED AS A
C        NFB    = FIELD NUMBER FOR COEFFICIENT TO BE STORED AS B
C        NFC    = FIELD NUMBER FOR COEFFICIENT TO BE STORED AS C
C        NFD    = FIELD NUMBER FOR COEFFICIENT TO BE STORED AS D
C
C        COMMON VARIABLES USED - A,B,C,D,IMN,LP,NPRRP
C
C        SUBROUTINES REQUIRED  - FRCL,PAGER
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 1 APRIL 1976
C
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
C
      COMMON/TFUN/A,B,C,D,ILO,IMN,IT,IUP,T,TLO,TUP
C
C
C---------INITIALIZE
      COEF=.FALSE.
      IERR=0
      IMN=7
      IMX=-1
C
C---------RECALL FIRST COEFFICIENT VALUE
      IF(NFA.LE.0) GO TO 20
      ISRC=7
      CALL FRCL(NFA,A,ISRC,IERR)
      IF(ISRC.LT.IMN) IMN=ISRC
      IF(ISRC.GT.IMX) IMX=ISRC
C
C---------RECALL SECOND COEFFICIENT VALUE
   20 IF(NFB.LE.0) GO TO 30
      ISRC=7
      CALL FRCL(NFB,B,ISRC,IERR)
      IF(ISRC.LT.IMN) IMN=ISRC
      IF(ISRC.GT.IMX) IMX=ISRC
C
C---------RECALL THIRD COEFFICIENT VALUE
   30 IF(NFC.LE.0) GO TO 40
      ISRC=7
      CALL FRCL(NFC,C,ISRC,IERR)
      IF(ISRC.LT.IMN) IMN=ISRC
      IF(ISRC.GT.IMX) IMX=ISRC
C
C---------RECALL FOURTH COEFFICIENT VALUE
   40 IF(NFD.LE.0) GO TO 50
      ISRC=7
      CALL FRCL(NFD,D,ISRC,IERR)
      IF(ISRC.LT.IMN) IMN=ISRC
      IF(ISRC.GT.IMX) IMX=ISRC
C
C---------TEST FOR ERROR CONDITIONS OR USE OF DEFAULT VALUES.
   50 IF(IERR.NE.0) GO TO 60
      IF(IMX.LE.1) GO TO 70
      RETURN

         ERROR IN RECALL OF FIELD VALUES
   [illegible] PAGER(2)
      [illegible] P,1000
```

```
C
C--------ALL COEFFICIENTS EITHER MISSING OR DEFAULT VALUES
   70 IF(NPRRP.EQ.0) GO TO 90
      CALL PAGER(2)
      WRITE(LP,1010)
C
   90 COEF=.TRUE.
      RETURN
C
 10000FORMAT (/ 5X,60H*****ERROR - COMPUTATION OF FUNCTION VALUE UNABLE
     1TO PROCEED/)
 1010 FORMAT ( 10X,33HTEMPERATURE FUNCTION IS UNDEFINED/)
      END
      FUNCTION ICOMP(ICODA,ICODB)
C
C        FUNCTION ICOMP PERFORMS A COMPARISON OF TWO CHEMICAL
C        RECOGNITION CODES, ICODA AND ICODB, AND RETURNS AN INTEGER
C        VALUE AS FOLLOWS -
C              ICOMP = -1 ,   ICODA .LT. ICODB
C              ICOMP =  0 ,   ICODA .EQ. ICODB
C              ICOMP = +1 ,   ICODA .GT. ICODB
C
C        THE COMPARISON REFLECTS THE SEQUENCE OF INTERNAL CHARACTER
C        CODES AND, FOR THREE CHARACTER NON-BLANK CODES, WILL PROVIDE
C        THE DESIRED ALPHABETIC SEQUENCE.  THIS ROUTINE ASSUMES THAT
C        THE CODES ARE STORED IN A3 FORMAT - THEREFORE BY DEFINITION
C        A BLANK (INTERNAL CODE 60) IS STORED IN THE FOURTH CHARACTER
C        POSITION.  SINCE THE LAST BIT IS ALWAYS ZERO, WORD CONTENTS
C        ARE SHIFTED ONE BIT POSITION RIGHT, THEN MANIPULATED TO DROP
C        THE SIGN BIT WHICH IS PRESENT FROM J TO Z.  THE FINAL
C        COMPARISON IS MADE ON BIT PATTERNS EQUIVALENT TO THOSE ON
C        INPUT, BUT SHIFTED BY ONE POSITION.
C
C
C        ICODA  = THREE CHARACTER RECOGNITION CODE, ARGUMENT
C        ICODB  = THREE CHARACTER RECOGNITION CODE, ARGUMENT
C        ICOMP  = INTEGER FUNCTION VALUE
C        IXA    = INTERNAL VARIABLE USED FOR MANIPULATION OF CONTENTS
C                    OF ARGUMENT ICODA
C        IXB    = INTERNAL VARIABLE USED FOR MANIPULATION OF CONTENTS
C                    OF ARGUMENT ICODB
C
C        COMMON VARIABLES USED - NONE
C
C        SUBROUTINES REQUIRED  - NONE
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 27 SEPTEMBER 1975
C
C
C--------COPY RECOGNITION CODES INTO INTERNAL VARIABLES FOR MANIPULATION
      IXA1=ICODA
      IXB1=ICODB
C
C--------SHIFT WORD CONTENTS TO RIGHT JUSTIFY.
      IXA=SHIFT(IXA1,18)
      IXB=SHIFT(IXB1,18)
C
C--------VARIABLES IXA AND IXB NOW CONTAIN THE SAME BIT PATTERN AS THE
C        ARGUMENTS ICODA AND ICODB, RIGHT JUSTIFIED, AND CAN BE COMPARED
      IF(IXA-IXB) 10,20,30
C
C        RETURN FOR ICODA .LT. ICODB
   10 ICOMP=-1
      RETURN
C
C        RETURN FOR ICODA .EQ. ICODB
   20 ICOMP=0
      RETURN
```

```
C
C       RETURN FOR ICODA .GT. ICODB
   30 ICOMP=+1
      RETURN
C
      END
      SUBROUTINE PCONV(NWTYP,NWVAL)
C
C         SUBROUTINE PCONV PERFORMS DATA UNIT CONVERSIONS OF PHYSICAL
C         PROPERTY DATA READ IN SI TO CGS UNITS FOR HACS COMPUTATIONS.
C         THIS ROUTINE, PERFORMING THE LIMITED CONVERSION OF SI TO CGS,
C         WAS ADAPTED FROM SUBROUTINE OCONV USED FOR GENERAL PROPERTY
C         FILE OUTPUT CONVERSIONS.  THE ARRAY OF VALUES ON INPUT, NWVAL,
C         IS REPLACED BY CONVERTED VALUES ON RETURN.  FIELD VALUES HAVING
C         A TYPE OF MISSING ARE NOT CONVERTED.
C
C         CONVERSION EQUATIONS ARE EVALUATED IN REVERSE FIELD SEQUENCE
C         DUE TO DEPENDENCIES AMONG CONVERSION EQUATIONS FOR TEMPERATURE
C         FUNCTION COEFFICIENTS.  WITHIN THE LOOP ON FIELD NUMBER, THE
C         ACTUAL CONVERSION EQUATIONS AND FACTORS TO BE APPLIED ARE
C         SELECTED BY BRANCHING ON THE TYPE OF PHYSICAL QUANTITY STORED
C         IN THE ARRAY XTQN AND INDEXED BY FIELD NUMBER.
C
C
C         AB      = TEMPERATURE CONVERSION FACTOR
C         AG      = SAME AS AB
C         IFLD    = INTEGER INDEX FOR FIELD NUMBER
C         IX      = INTEGER VARIABLE USED FOR INDEX IFLD+1 IN TEMPERATURE
C                     FUNCTION COEFFICIENT CONVERSIONS
C         KTYP    = INDEX GIVING TYPE OF QUANTITY FOR FIELD IFLD USED
C                     TO REFERENCE CONVERSION DATA ARRAYS AND CONTROL
C                     THE SELECTION OF CONVERSION EQUATIONS
C         NWTYP   = SOURCE STATUS CODES FOR FIELD VALUES READ FROM
C                     PROPERTY FILE (0=MISSING, 2=ESTIMATE, 3=EXACT)
C         NWVAL    = ARRAY OF PROPERTY FILE FIELD VALUES
C         TEMP    = TEMPORARY VARIABLE FOR PARTIRAL SUM OF CONVERSION
C                     EQUATION TERMS
C         XCNV    = ARRAY OF CONVERSION FACTORS USED IN SCALAR PRODUCTS
C                     OR CONVERSION EQUATIONS ACCORDING TO FIELD NUMBER
C                     AND TYPE OF PHYSICAL QUANTITY.
C         XTQN    = INTEGER ARRAY GIVING TYPE OF PHYSICAL QUANTITY FOR
C                     EACH FIELD (1 TO 74).  VALUES SHOULD NOT BE
C                     INTERPRETED TOO RIGIDLY BY PHYSICAL DEFINITION AS
C                     SOME DEGREE OF REDUNDANCY MAY BE INTENTIONALLY
C                     INCLUDED TO SIMPLIFY CONVERSION PROCESSING.
C
C
C         COMMON VARIABLES USED - NONE
C
C         SUBROUTINES REQUIRED  - NONE
C
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                              35/309A ACORN PARK,
C                              CAMBRIDGE, MASS., 02140
C                              TEL. 617-864-5770  EXT. 2813
C         DATE   - 27 SEPTEMBER 1975
C
C
      DIMENSION NWTYP(1),NWVAL(1),XCNV(30),XTQN(74)
      INTEGER   XTQN
      REAL      NWVAL
C
      DATA AB/273.15/,AG/273.15/
C
     0DATA (XCNV(I),I=1,30)
     1   /0.0       ,1.0       ,273.15    ,0.1       ,1000.     ,
     2    273.15    ,1000.     ,1000.     ,1000.     ,0.1       ,
     3    -2.30259  ,418.68    ,418.68    ,4186.8    ,4186.8    ,
     4    0.001     ,1.0       ,1.0       ,2.12483   ,4186.8    ,
     5    4186.8    ,4186.8    ,4186.8    ,4186.8    ,1.0       ,
     6    0.01      ,1.0       ,1.0       ,1.0       ,1.0       /
```

```
C
      0DATA (XTQN(I),I=1,74)
      1    / 1, 1, 1, 2, 3, 3, 3, 4, 5, 6, 1, 7, 8, 9, 6, 6,10, 6,11, 3,
      2       6, 6,12, 6,12,13, 6, 6,14, 6,14,15, 6, 6,16, 6,16, 6,17, 6,
      3      17,18,19, 6, 6, 6, 6,20,21,22,23, 3, 3,24,24,24,24,24,24,24,
      4      25,25,26,27,27,28,29,29, 1, 6,30,30, 6,30/
C
C
C--------INITIALIZE LOOP ON PROPERTY FIELDS.  SEQUENCE IS IN REVERSE
C        ORDER TO PERMIT SEQUENTIAL CONVERSION OF TEMPERATURE FUNCTION
C        COEFFICIENTS.
      IFLD=74
C--------RETURN HERE FOR EACH NEW FIELD, SKIP CONVERSION IF FIELD
C        VALUE IS MISSING.
   10 IF(NWTYP(IFLD).EQ.0) GO TO 20
C--------BRANCH ON TYPE OF QUANTITY TO CONVERSION EQUATIONS FOR
C        EACH FIELD.
      KTYP=XTQN(IFLD)
      0GO TO(  20,   20, 300, 400, 400, 600, 700, 800, 900, 400,
      1        1100,1200,1300,1400,1300, 400,1700,1300,1100,2000,
      2        2100,2200,2300, 400,  20, 400,  20, 400, 400,  20),KTYP
C
C--------RETURN HERE FOLLOWING CONVERSION TO PICK UP NEXT FIELD.
C        SKIP ALHPANUMERIC FIELDS 1,2,3
   20 IFLD=IFLD-1
      IF(IFLD.GT.3) GO TO 10
      RETURN
C
C--------CONVERSION EQUATIONS
C
C--------KTYP=1, FIELDS 1,2,3,11,69, NO CONVERSION REQUIRED
C 100 GO TO 20
C--------KTYP=2, FIELD 4, ALL CONVERSION FACTORS ARE UNITY
C 200 GO TO 20
C--------KTYP=3, FIELDS 5,6,7,20,52,53
  300 IF(IFLD.EQ.20) GO TO 320
  310 NWVAL(IFLD)=NWVAL(IFLD)-XCNV(KTYP)
  320 GO TO 20
C--------KTYP=4, FIELD 8
  400 NWVAL(IFLD)=NWVAL(IFLD)/XCNV(KTYP)
      GO TO 20
C--------KTYP=5, FIELD 9
C 500 GO TO 400
C--------KTYP=6, FIELDS 10,15,16,18,21,22,24,27,28,30,33,34,36,38,
C                       40,44,45,46,47,70,73
  600 IF(IFLD.EQ.44) GO TO 320
      IF(IFLD.NE.45) GO TO 310
      NWVAL(45)=AG+NWVAL(45)
      GO TO 20
C--------KTYP=7, FIELD 12
  700 TEMP=AG*(NWVAL(13)-AG*NWVAL(14))
      GO TO 2340
C--------KTYP=8, FIELD 13
  800 TEMP=2.*AG*NWVAL(14)
      GO TO 2330
C--------KTYP=9, FIELD 14
  900 TEMP=0.0
      GO TO 2320
C--------KTYP=10, FIELD 17
C1000 GO TO 400
C--------KTYP=11, FIELD 19
 1100 NWVAL(IFLD)=NWVAL(IFLD)-XCNV(KTYP)
      GO TO 20
C--------KTYP=12, FIELDS 23,25
 1200 IF(IFLD.EQ.23) GO TO 400
 1210 IX=IFLD+1
      TEMP=AG*NWVAL(IX)
      GO TO 2340
C--------KTYP=13, FIELD 26
 1300 TEMP=0.0
      GO TO 2330
C--------KTYP=14, FIELDS 29,31
```

```
 1400 IF(IFLD.EQ.29) GO TO 400
      GO TO 1210
C--------KTYP=15, FIELD 32
C1500 GO TO 1300
C--------KTYP=16, FIELDS 35,37
C1600 GO TO 400
C--------KTYP=17, FIELDS 39,41, CONVERSION FACTORS FOR FIELD 39 ARE 1.0
 1700 IF(IFLD.EQ.41) GO TO 1210
      GO TO 20
C--------KTYP=18, FIELD 42
C1800 GO TO 1300
C--------KTYP=19, FIELD 43
C1900 GO TO 1100
C--------KTYP=20, FIELD 48
 2000 TEMP=AB*(NWVAL(49)-AB*(NWVAL(50)-AB*NWVAL(51)))
      GO TO 2340
C--------KTYP=21, FIELD 49
 2100 TEMP=AB*(2.*NWVAL(50)-3.*AB*NWVAL(51))
      GO TO 2330
C--------KTYP=22, FIELD 50
 2200 TEMP=3.*AB*NWVAL(51)
      GO TO 2320
C--------KTYP=23, FIELD 51
 2300 TEMP=0.0
 2320 CONTINUE
 2330 CONTINUE
 2340 NWVAL(IFLD)=TEMP+NWVAL(IFLD)/XCNV(KTYP)
      GO TO 20
C--------KTYP=24, FIELDS 54,55,56,57,58,59,60
C2400 GO TO 400
C--------KTYP=25, FIELDS 61,62, CONVERSION FACTORS ARE UNITY.
C2500 GO TO 20
C--------KTYP=26, FIELD 63
C2600 GO TO 400
C--------KTYP=27, FIELDS 64,65, NO CONVERSION REQUIRED
C2700 GO TO 20
C--------KTYP=28, FIELD 66
C2800 GO TO 400
C--------KTYP=29, FIELDS 67,68
C2900 GO TO 400
C--------KTYP=30, FIELDS 71,72,74, NO CONVERSION REQUIRED
C3000 GO TO 20
C
C
      END
      SUBROUTINE PROP(INDXX)
C
C         SUBROUTINE PROP SEARCHES THE HACS PHYSICAL PROPERTY DATA FILE
C         FOR A COMPOUND HAVING A RECOGNITION CODE GIVEN BY ICD AND
C         RETRIEVES PROPERTY DATA VALUES.  PROPERTY VALUES ARE FIRST
C         CONVERTED FROM SI UNITS TO CGS UNITS AND THEN STORED IN THE
C         HACS STATE FILE.  THE ARRAY FLDN ESTABLISHES THE CORRESPONDENCE
C         BETWEEN PROPERTY FILE FIELD NUMBERS (1 TO 74) AND HACS STATE
C         FILE FIELD NUMBERS.  ONLY EXACT OR ESTIMATED PROPERTY VALUES
C         ARE TRANSFERRED TO HACS.  AFTER THE TRANSFER, FIELD VALUES
C         ARE RECALLED AND USED IN THE COMPUTATION OF TEMPERATURE
C         FUNCTION VALUES AT AMBIENT AND BOILING POINT.  IF THE USER
C         SPECIFIED RECOGNITION CODE IS GIVEN INCORRECTLY AND THE
C         CHEMICAL IS NOT FOUND ON THE FILE, ERROR MESSAGES ARE GIVEN
C         AND THE OPERATION FLAG NOP IS SET TO ZERO TO FORCE JOB
C         TERMINATION ON RETURN.
C
C         FLDN   = INTEGER ARRAY GIVING FIELD NUMBER IN HACS STATE FILE
C                    CORRESPONDING TO PROPERTY FILE ITEM NUMBER (1 TO 74)
C                    VALUE IS ZERO IF PROPERTY ITEM IS NOT TRANSFERRED
C                    TO HACS.
C         HDR    = SIX-WORD INTEGER HEADER ARRAY APPEARING AS FIRST
C                    RECORD ON PROPERTY FILE GIVING LABEL AS FOLLOWS -
C                    WORD 1 = DATE OF RUN CREATING BACK-UP FILE IN
C                             I6 FORMAT AS MMDDYY
C                    WORD 2 = VERSION NUMBER OF BACK-UP FILE
C                    WORD 3 = DATE OF UPDATE RUN CREATING FILE IN
```

```
C                           I6 FORMAT AS MMDDYY
C                 WORD 4 = SEQUENTIAL VERSION NUMBER (INCREMENTED
C                           BY 1 ON EACH UPDATE CYCLE)
C                 WORD 5 = TAPE FILE IDENTIFICATION IN A4 FORMAT
C                 WORD 6 = IDENTIFICATION OF TAPE FILE USED AS INPUT
C                           TO UPDATE RUN CREATING CURRENT FILE
C                           (BACK-UP FILE ID IN A4 FORMAT)
C        I       = FORTRAN LOOP INDEX
C        IERR    = ERROR INDICATOR SET IN HACS STATE FILE RECALL
C                    OPERATION.  USE REPLACED BY SOURCE CODE OF 0
C                    ALSO RETURNED FOR ERROR CONDITION.
C        ITAM    = SOURCE CODE FOR VALUE OF AMBIENT TEMPERATURE STORED
C                    IN STATE FILE
C        ITBP    = SOURCE CODE FOR VALUE OF BOILING TEMPERATURE STORED
C                    IN STATE FILE
C        ITP     = FORTRAN I/O UNIT REFERENCE NUMBER FOR PHYSICAL
C                    DEVICE ON WHICH PROPERTY DATA IS STORED
C        TAM     = VALUE OF AMBIENT TEMPERATURE RECALLED FROM HACS FILE
C        TBP     = VALUE OF BOILING TEMPERATURE RECALLED FROM HACS FILE
C        VAL     = COMPUTED VALUE OF ANY FUNCTION OF TEMPERATURE
C        YCOD    = CHEMICAL RECOGNITION CODE READ FROM PROPERTY FILE,
C                    INTEGER EQUIVALENCED TO YVAL(1)
C        YNAM    = COMPOUND NAME READ FROM PROPERTY FILE, STORED AS 5A8
C        YPTH    = ARRAY OF PATH CODES READ FROM PROPERTY FILE, STORED
C                    AS UP TO 15 A4 PATH CODES IN EIGHT A8 DATA WORDS -
C                    LAST PART OF LAST DATA WORD IS NOT USED.
C        YTYP    = ARRAY OF STATUS CODES FOR EACH (1 TO 74) PROPERTY
C                    FIELD VALUE.  CODES ARE 0 FOR MISSING, 2 FOR
C                    ESTIMATED AND 3 FOR EXACT PROPERTY VALUES.
C        YVAL    = REAL ARRAY FOR PROPERTY DATA VALUES.  WORDS 2 AND 3,
C                    CORRESPONDING TO COMPOUND NAME AND PATH CODES,
C                    RESPECTIVELY, ARE NOT USED.
C
C        COMMON VARIABLES USED - A,B,C,D,ICD,ILO,IPRRP,IT,IUP,LP,NOP,
C                                NPRRP,T,TLO,TUP
C
C        SUBROUTINES REQUIRED  - BNDCK,COEF,EXP,FRCL,FSV,ICOMP,IFEOF,
C                                PAGER,PCONV
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 6 APRIL 1976
C
C
      0COMMON/CNTRL/EOFF,ICD,IDFLT,LBL(4),LSTCN(3,3),MODEL(15),NOP,
      1             STCON,SVCON
       INTEGER      EOFF,STCON,SVCON
       REAL         LBL
C
       COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
       COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
C
       COMMON/TFUN/A,B,C,D,ILO,IMN,IT,IUP,T,TLO,TUP
C
C
C        A       = TEMPERATURE FUNCTION COEFFICIENT A
C        B       = TEMPERATURE FUNCTION COEFFICIENT B
C        C       = TEMPERATURE FUNCTION COEFFICIENT C
C        D       = TEMPERATURE FUNCTION COEFFICIENT D
C        IMN     = LOWEST SOURCE CODE FOUND ON RECALL OF COEFFICIENTS
C        ILO     = SOURCE CODE FOR VALUE OF TLO IN STATE FILE
C        IT      = SOURCE CODE FOR COMPUTED FUNCTION VALUE OBTAINED AS
C                    MINIMUM SOURCE CODE OF ALL VALUES ON RIGHT HAND
C                    SIDE OF EQUATION.
C        IUP     = SOURCE CODE FOR VALUE OF TUP IN STATE FILE
C        T       = VALUE OF TEMPERATURE TO BE USED IN COMPUTING FUNCTION
C                    VALUE, OBTAINED FROM AMBIENT AND BOILING TEMPERATURE
C                    ADJUSTED IF NECESSARY TO RANGE OF EQUATION
C        TLO     = LOWER LIMIT OF TEMPERATURE RANGE FOR WHICH EQUATION
```

```
C                    HAS BEEN DEFINED
C         TUP     = UPPER LIMIT OF TEMPERATURE RANGE FOR WHICH EQUATION
C                    HAS BEEN DEFINED
C
C
      COMMON/PXFER/BUFF,K,SNCOD
      INTEGER SNCOD
      INTEGER   FLDN(74),HDR(6),YCOD,YTYP(74)
      LOGICAL   COEF
      DIMENSION YNAM(5),YVAL(74),FREF(84)
      INTEGER   OREC(84),TCOD(5),BUFF(15),PTLST(29),SCOD,SCLST(28)
     0EQUIVALENCE (OREC(1),YCOD,FREF(1)),(OREC(2),YNAM(1)),
     1            (OREC(7),MCOD),(OREC(8),SCOD),(OREC(9),TCOD(1)),
     2            (OREC(14),YVAL(4)),(HDR(1),OREC(1))
     0DATA (PTLST(I),I=1,29)/1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,
     1     1HK,1HL,1HM,1HN,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,
     2     1HZ,2HII,2HRR,2HSS/
     0DATA (SCLST(I),I=1,28)/3HA B,3HA C,5HA B C,5HA D E,7HA D F G,
     1     9HA D E F G,3HA H,5HA I J,7HA H I J,5HA K L,7HA K M N,
     2     9HA K L M N,3HA O,3HA P,5HA P Q,7HA P R S,9HA P Q R S,
     3     3HA T,5HA T U,5HA V W,9HA T U V W,3HA X,5HA X Y,1HZ,2HII,
     4     2HRR,4HRR C,2HSS/
C
      DATA      ITP/9/
     0DATA (FLDN(I),I=1,74)
     1    /   0,   0,   0,1002,1003,1033,1025,1034,1035,1036,
     2        0,1038,1039,1040,1041,1042,1043,1044,1045,1046,
     3     1047,1048,1049,1050,1051,1052,1053,1054,1055,1056,
     4     1057,1058,1059,1060,1008,1061,1031,1032,1026,1027,
     5     1028,1029,1010,1011,1012,1062,1063,1064,1065,1066,
     6     1067,1068,1069,1070,1014,1071,1072,1073,1074,1075,
     7     2033,1076,1015,2032,1077,1078,1079,1080,   0,1016,
     8     1017,1018,1019,1020/
C
C
C
      INDXX=1
C--------SET UP AUDIT OPTION
      NPRRP=IPRRP
C--------WRITE STATUS MESSAGE TO USER OUTPUT
      IF(NPRRP.EQ.1) CALL PAGER(0)
C     CALL PAGER(1)
C     WRITE(LP,1000) ICD
C
C--------REWIND TAPE AND READ HEADER RECORD.  TERMINATE IF GET END FILE.
      REWIND ITP
      BUFFER IN(ITP,1) (HDR(1),HDR(6))
      IF(UNIT(ITP)) 30,5,5
C
C--------INITIAL END OF FILE ERROR CONDITION
    5 CALL PAGER(2)
      WRITE(LP,1010)
C
C--------ERROR RETURN
   10 NOP=0
C
C--------NORMAL RETURN
   20 CONTINUE
      REWIND ITP
C
C--------RESTORE OUTPUT AUDIT
      NPRRP=1
      RETURN
   30 CONTINUE
C
C--------DISPLAY FILE HEADER
C  30 CALL PAGER(3)
C     WRITE(LP,1020) HDR(5),HDR(4),HDR(3),HDR(6),HDR(2),HDR(1)
C
C--------RETURN HERE TO READ NEXT PHYSICAL PROPERTY RECORD
C
C--------TEST FOR END OF FILE.  GIVE ERROR MESSAGE AND RETURN IF
```

```
C         CHEMICAL HAS NOT BEEN FOUND.
   40 BUFFER IN(ITP,1) (OREC(1),OREC(84))
      IF(UNIT(ITP)) 50,41,41
   41 CALL PAGER(2)
      WRITE(LP,1030)
   42 INDXX=0
      GO TO 20
C
C--------COMPARE COMPOUND RECOGNITION CODE DESIRED TO ONE JUST READ
   50 CONTINUE
      IF(ICOMP(YCOD,ICD)) 40,70,60
C
C--------TAPE HAS BEEN SEARCHED PAST POSITION FOR ICD.
   60 CALL PAGER(3)
      WRITE(LP,1040)
      GO TO 42
C
C--------PROPERTIES OF REQUESTED COMPOUND HAVE BEEN FOUND.  PRINT DATA
C         FIELDS WHICH ARE NOT TRANSFERRED TO HACS.
   70 CALL INIT(YTYP,30,5,2)
      DO 2000 I=1,74
 2000 YTYP(I)=ITST(TCOD,I)
      K=LENGTH(ITP)+1
      K1=85
      DO 2020 J=4,74
      I=78-J
      K1=K1-1
      IF(YTYP(I).EQ.0) GO TO 2010
      K=K-1
      FREF(K1)=FREF(K)
      GO TO 2020
 2010 FREF(K1)=0.0
 2020 CONTINUE
      CALL PAGER(4)
      WRITE(LP,2030) YCOD,YNAM,YVAL(11)
 2030 FORMAT (/5X,46HPHYSICAL PROPERTY DATA RETRIEVED FOR CHEMICAL ,A3/
     1 9X,7HNAME = ,5A8/9X,17HSHIPPING STATE = ,A8)
      CALL INIT(ITMP,29,1,1)
      K=0
      DO 2040 I=1,29
      ITMP=ITST(MCOD,I)
      IF(ITMP.EQ.0) GO TO 2040
      K=K+1
      BUFF(K)=PTLST(I)
 2040 CONTINUE
      SNCOD=SCOD
      IF(NPRRP.EQ.0) GO TO 71
      CALL PAGER(4)
      WRITE(LP,1060)
   71 CONTINUE
C
C--------CONVERT FIELD VALUES FROM SI UNITS AS READ FROM PROPERTY FILE
C         TO CGS UNITS FOR INTERNAL HACS USE.
      CALL PCONV(YTYP,YVAL)
C
C--------LOOP THROUGH FIELD NUMBER LIST AND TRANSFER EXACT OR ESTIMATED
C         VALUES OF UNIT DATA FIELDS TO HACS.  IF FIELD NUMBER IS ZERO,
C         VALUE IS NOT TRANSFERRED.
      DO 80 I=4,74
      IF(FLDN(I).EQ.0) GO TO 80
      IF(YTYP(I).EQ.0) GO TO 80
      CALL FSV(FLDN(I),YVAL(I),YTYP(I))
   80 CONTINUE
      GO TO 20
C
C--------COMPUTATION OF TEMPERATURE FUNCTION VALUES AT AMBIENT AND
C         BOILING TEMPERATURE.
      IF(NPRRP.EQ.0) GO TO 81
      CALL PAGER(0)
      CALL PAGER(2)
      WRITE(LP,1070)
   81 CONTINUE
```

```
C--------RECALL VALUES IN STATE FILE AND SAVE SOURCE CODES
      ITAM=7
      NXXX=NPRRP
      NPRRP=1
      CALL FRCL(2004,TAM,ITAM,IERR)
      NPRRP=NXXX
      ITBP=7
      CALL FRCL(FLDN(5),TBP,ITBP,IERR)
C
C--------COMPUTATION OF SATURATED LIQUID DENSITY.
      IF(NPRRP.EQ.0) GO TO 82
      CALL PAGER(2)
      WRITE(LP,1080)
   82 CONTINUE
      IF(COEF(FLDN(12),FLDN(13),FLDN(14),0)) GO TO 90
      CALL BNDCK(1,TAM,ITAM,FLDN(16),FLDN(15))
      VAL=A+T*(B+T*C)
      CALL FSV(1004,VAL,IT)
      CALL BNDCK(2,TBP,ITBP,0,0)
      VAL=A+T*(B+T*C)
      CALL FSV(1021,VAL,IT)
C
C--------COMPUTATION OF LIQUID VISCOSITY.
   90 IF(NPRRP.EQ.0) GO TO 91
      CALL PAGER(2)
      WRITE(LP,1090)
   91 CONTINUE
      IF(COEF(FLDN(19),FLDN(20),0,0)) GO TO 100
      CALL BNDCK(1,TAM,ITAM,FLDN(22),FLDN(21))
      VAL=EXP(A+B/(T+273.15))
      CALL FSV(1006,VAL,IT)
      CALL BNDCK(2,TBP,ITBP,0,0)
      VAL=EXP(A+B/(T+273.15))
      CALL FSV(1005,VAL,IT)
C
C--------COMPUTATION OF LIQUID THERMAL CONDUCTIVITY.
  100 IF(NPRRP.EQ.0) GO TO 101
      CALL PAGER(2)
      WRITE(LP,1100)
  101 CONTINUE
      IF(COEF(FLDN(25),FLDN(26),0,0)) GO TO 110
      CALL BNDCK(1,TAM,ITAM,FLDN(28),FLDN(27))
      VAL=A+B*T
      CALL FSV(1081,VAL,IT)
      CALL BNDCK(2,TBP,ITBP,0,0)
      VAL=A+B*T
      CALL FSV(1082,VAL,IT)
C
C--------COMPUTATION OF LIQUID HEAT CAPACITY.
  110 IF(NPRRP.EQ.0) GO TO 111
      CALL PAGER(2)
      WRITE(LP,1110)
  111 CONTINUE
      IF(COEF(FLDN(31),FLDN(32),0,0)) GO TO 120
      CALL BNDCK(1,TAM,ITAM,FLDN(34),FLDN(33))
      VAL=A+B*T
      CALL FSV(1007,VAL,IT)
      CALL BNDCK(2,TEP,ITBP,0,0)
      VAL=A+B*T
      CALL FSV(1083,VAL,IT)
C
C--------COMPUTATION OF SOLUBILITY.  NOTE THAT TEMPERATURE BOUNDS ARE
C           PRE-SPECIFIED AND NOT STORED ON THE PROPERTY FILE.
  120 IF(NPRRP.EQ.0) GO TO 121
      CALL PAGER(2)
      WRITE(LP,1120)
  121 CONTINUE
      IF(COEF(FLDN(41),FLDN(42),0,0)) GO TO 130
      TLO=0.0
      ILO=3
      TUP=30.0
      IUP=3
```

```
      CALL BNDCK(2,TAM,ITAM,0,0)
      VAL=A+B*T
      CALL FSV(1084,VAL,IT)
      CALL BNDCK(2,TBP,ITBP,0,0)
      VAL=A+B*T
      CALL FSV(1085,VAL,IT)
C
C--------COMPUTATION OF SATURATED VAPOR PRESSURE
  130 IF(NPRRP.EQ.0) GO TO 131
      CALL PAGER(2)
      WRITE(LP,1130)
  131 CONTINUE
      IF(COEF(FLDN(43),FLDN(44),FLDN(45),0)) GO TO 140
      CALL BNDCK(1,TAM,ITAM,FLDN(47),FLDN(46))
      VAL=10.0**(A-B/(T+C))
      CALL FSV(1086,VAL,IT)
      CALL BNDCK(2,TBP,ITBP,0,0)
      VAL=10.0**(A-B/(T+C))
      CALL FSV(1087,VAL,IT)
C
C--------COMPUTATION OF VAPOR HEAT CAPACITY
  140 IF(NPRRP.EQ.0) GO TO 141
      CALL PAGER(2)
      WRITE(LP,1140)
  141 CONTINUE
      IF(COEF(FLDN(48),FLDN(49),FLDN(50),FLDN(51))) GO TO 20
      CALL BNDCK(1,TAM,ITAM,FLDN(53),FLDN(52))
      VAL=A+T*(B+T*(C+T*D))
      CALL FSV(1013,VAL,IT)
      CALL BNDCK(2,TBP,ITBP,0,0)
      VAL=A+T*(B+T*(C+T*D))
      CALL FSV(1088,VAL,IT)
      GO TO 20
C
 10000FORMAT (5X,65HSTARTING SEARCH OF HACS FILE FOR PHYSICAL PROPERTIES
     1 OF CHEMICAL ,A3,4H ...)
 1010 FORMAT (/5X,46H*****ERROR - UNABLE TO READ HACS PROPERTY FILE)
 10200FORMAT (/10X,21HFILE OPENED HAS ID = ,A4,20H,  VERSION NUMBER = ,
     1 I5,10H,  DATE = ,I6/13X,18HBACK-UP FILE ID = ,A4,20H,  VERSION NU
     2MBER = ,I5,10H,  DATE = ,I6)
 10300FORMAT (/5X,71H*****ERROR - UNABLE TO FIND CHEMICAL.  SEARCH TERMI
     1NATED BY END OF FILE)
 10400FORMAT (/5X,56H*****ERROR - UNABLE TO FIND CHEMICAL.  SEARCH TERMI
     1NATED/10X,45HAFTER PASSING EXPECTED ALPHABETICAL POSITION.)
 10500FORMAT (/5X,46HPHYSICAL PROPERTY DATA RETRIEVED FOR CHEMICAL ,A3/
     1 9X,7HNAME = ,5A8/9X,13HPATH CODES = ,8A8/9X,17HSHIPPING STATE = ,
     2 A8)
 10600FORMAT (/5X,46HTRANSFER OF EXACT OR ESTIMATED PROPERTY VALUES/
     1          5X,30HTO HACS STATE FILE FOLLOWS .../)
 10700FORMAT ( 5X,72HCOMPUTATION OF FUNCTIONS OF TEMPERATURE FOLLOW USIN
     1G TEMPERATURES OF .../)
 1080 FORMAT ( 5X,43HCOMPUTATION OF SATURATED LIQUID DENSITY .../
 1090 FORMAT ( 5X,35HCOMPUTATION OF LIQUID VISCOSITY .../)
 1100 FORMAT ( 5X,46HCOMPUTATION OF LIQUID THERMAL CONDUCTIVITY .../)
 1110 FORMAT ( 5X,39HCOMPUTATION OF LIQUID HEAT CAPACITY .../)
 1120 FORMAT ( 5X,38HCOMPUTATION OF SOLUBILITY IN WATER .../)
 1130 FORMAT ( 5X,43HCOMPUTATION OF SATURATED VAPOR PRESSURE .../)
 1140 FORMAT ( 5X,38HCOMPUTATION OF VAPOR HEAT CAPACITY .../)
      END
      SUBROUTINE PTHCK(ULST,PTLST,MODNO,ISW)
C
C         SUBROUTINE PATH CHECK COMPARES THE RATE MODEL LETTER CODES
C         GIVEN AS INPUT (STORED IN ULST) TO THE LIST OF VALID CODES
C         STORED IN THE DATA ARRAY PTLST.  ON RETURN, THE ARRAY MODNO
C         CONTAINS INDEX NUMBERS FOR EACH INPUT LETTER AND ISW GIVES
C         THE STATUS OF THE CHECKING OPERATION AS FOLLOWS-
C
C         ISW = 0    NORMAL RETURN
C
C         ISW = 1    THE INPUT LIST CONTAINS AN UNRECOGNIZABLE AND NON-
C                    BLANK RATE MODEL CODE.  THE ARRAY MODNO IS ONLY
C                    PARTIALLY COMPLETED ON OUTPUT AND SHOULD NOT BE USED
```

```
C
C        ISW = 2     MODEL CODES SPECIFIED BY USER APPEAR TO BE ALL
C                    BLANK, OR HAVE MISSING PATH CODES IN LIST
C
C        ISW = 3     MODEL CODES SPECIFIED BY THE USER ARE NOT IN THE
C                    PROPER SEQUENCE FOR A HAZARD ASSESSMENT PATH
C                    (EXCEPT FOR O, Z, II, RR AND SS) OR AT LEAST ONE
C                    PATH CODE (INCLUDING O, Z, II, RR AND SS) APPEARS
C                    MORE THAN ONCE.
C
C        ISW = 4     A MODEL CODE IS MISSING IN THE LIST GIVEN BY THE
C                    USER
C
C        ON RETURN WITH ISW = 0,2,3 OR 4, THE ARRAY MODNO GIVES THE
C        INDEX NUMBER FOR EACH MODEL SPECIFIED IN THE USER LIST. IF
C        ISW=2, HACS MAY EITHER TERMINATE, OR SELECT DEFAULT CODES
C        FROM THE PROPERTY FILE.  CASES WITH ISW=3 OR 4 MAY BE VALID,
C        BUT A WARNING MESSAGE SHOULD BE DISPLAYED.  THE PROPERTY FILE
C        UPDATE PROGRAM DOES NOT USE THE ARRAY MODNO AND SHOULD PRO-
C        DUCE A FATAL ERROR ON ALL RETURNS EXCEPT ISW=0.
C
C        PATH CHECK SEQUENCE TESTS ARE SUPPRESSED IN THIS VERSION OF
C        SUBROUTINE PTHCK FOR RATE MODELS O, Z, II, RR AND SS WHICH
C        MAY APPEAR AT ANY LOCATION IN THE INPUT LIST.  ADDITIONAL
C        LOGIC IS INCLUDED HOWEVER TO GENERATE A SEQUENCE ERROR IF
C        ANY OF THESE EXCEPTIONS APPEARS MORE THAN ONCE IN THE INPUT
C        LIST.  NOTE THAT THE SEQUENCE CHECK APPLIED TO THE REMAINING
C        PATH CODES AUTOMATICALLY SUPPRESSES DUPLICATION.
C
C
C
C        I       = INTEGER LOOP INDEX
C        ISW     = ARGUMENT, STATUS INDICATOR ON RETURN TO CALLING
C                    ROUTINE
C        J       = INTEGER LOOP INDEX
C        LAST    = TEMPORARY VARIABLE USED FOR STORAGE OF PREVIOUS
C                    VALUE, MODNO(I-1)
C        MODNO   = ARRAY OF NUMERIC INDICES CORRESPONDING TO USER
C                    SPECIFIED RATE MODEL LETTERS (1 TO 26 FOR A TO Z,
C                    27=II, 28=RR, 29=SS AND 30 FOR BLANK)
C        PTLST   = ARGUMENT, DATA ARRAY CONTAINING ALL VALID RATE
C                    MODEL LETTERS, A TO Z, II, RR, SS, AND BLANK.
C        ULST    = ARGUMENT, ARRAY CONTAINS RATE MODEL LETTERS SPECIFIED
C                    BY USER ON INPUT.
C
C        COMMON VARIABLES USED - NONE
C
C        SUBROUTINES REQUIRED  - NONE
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 10 JULY 1975
C
C
      INTEGER   MODNO(15),PTLST(30),ULST(15)
C
C
C---------INITIALIZE RETURN STATUS CODE, AND START LOOP ON WORDS IN USER
C        INPUT LIST.
      ISW=0
      DO 20 I=1,15
C        START LOOP ON LIST OF VALID MODEL NAMES
      DO 10 J=1,30
      IF(ULST(I).NE.PTLST(J)) GO TO 10
C        GOT A MATCH. STORE AND SKIP UP TO OUTER LOOP
      MODNO(I)=J
      GO TO 20
   10 CONTINUE
C        DID NOT FIND A MATCH. RETURN.
      ISW=1
      RETURN
```

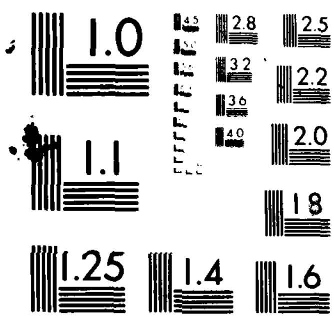
```
   20 CONTINUE
C
C--------CHECK SEQUENCE OF PATH CODES.  AT LEAST ONE NON-BLANK CODE
C          MUST APPEAR
      IF(MODNO(1).EQ.30) GO TO 60
      LAST=0
      DO 50 I=1,15
      IF(LAST.EQ.30) GO TO 30
      IF(MODNO(I).GT.LAST) GO TO 40
C
C--------MODEL CODE OUT OF SEQUENCE.  TEST FOR EXCEPTION, OTHERWISE
C          SET ERROR RETURN
      IF(MODNO(I).EQ.15) GO TO 24
      IF(MODNO(I).EQ.26) GO TO 24
      IF(MODNO(I).EQ.27) GO TO 24
      IF(MODNO(I).EQ.28) GO TO 24
      IF(MODNO(I).EQ.29) GO TO 24
   22 ISW=3
      RETURN
C
C--------CHECK FOR DUPLICATION OF PATH CODES WHICH ARE EXCEPTIONS TO
C          ASCENDING SEQUENCE RULE.
   24 DO 26 J=1,I
      IF(J.EQ.I) GO TO 50
      IF(MODNO(J).EQ.MODNO(I)) GO TO 22
   26 CONTINUE
      GO TO 50
C
   30 IF(MODNO(I).EQ.LAST) GO TO 50
      ISW=4
      RETURN
   40 LAST=MODNO(I)
   50 CONTINUE
      RETURN
   60 ISW=2
      RETURN
      END
      SUBROUTINE RNTIO
C
C          THIS ROUTINE IS CALLED IMMEDIATELY AFTER A USERS BASIC INPUT
C          DATA DECK IS READ TO SET UP OPTIONS SELECTED FOR INPUT/OUTPUT
C          CONTROL DURING AN ASSESSMENT RUN.  FIELD VALUES FROM THE
C          HACS STATE FILE ARE ACCESSED AND STORED IN COMMON FOR USE
C          IN EXECUTING OR SKIPPING PORTIONS OF HACS I/O DURING THE
C          ASSESSMENT RUN.  EACH SET OF OPTIONS REMAINS IN EFFECT UNTIL
C          THE NEXT SET OF USER INPUT CARDS ARE READ.  DIFFERENT RUN
C          SET UPS MAY BE USED TO SIMPLIFY HACS OPERATIONS DEPENDING
C          ON THE TYPE OF OPTIONS TO BE SELECTED.
C
C          IR      = ERROR INDICATOR FOR DATA BASE RECALL, NOT USED
C          IS      = SOURCE CODE TRACK FOR DATA BASE RECALL, NOT USED
C
C          COMMON VARIABLES USED - ICVSL,IPRAC,IPRRP,LP,NOFF,NPRRP,WIND
C
C          SUBROUTINES REQUIRED  - FRCL,IRCL,PAGER
C
C          AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                               35/309A ACORN PARK,
C                               CAMBRIDGE, MASS., 02140
C                               TEL. 617-864-5770  EXT. 2813
C          DATE   - 17 MAY 1976
C
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      COMMON/IOCNT/ICVSL,IPRAC,IPRRP,NOFF,NPRRP
C
      COMMON/PLTCN/ANG,IBUF(4000),IFRST,IPLT,WIND
C
C
C--------AUDIT RUN TIME I/O OPTIONS SELECTED BY USER OR OBTAINED
C          BY DEFAULT
```

```
      CALL PAGER(3)
      NPRRP=1
C
      IR=0
      IS=6
      WRITE(LP,2010)
 2000 FORMAT (40H OUTPUT OPTIONS ARE 0=SUPPRESS, 1=SELECT)
      CALL IRCL(3019,ICVSL,IS,IR)
      WRITE(LP,2000)
      CALL IRCL(3002,NOFF,IS,IR)
      IF(NOFF.NE.0) CALL FRCL(2016,WIND,IS,IR)
      WRITE(LP,2000)
      CALL IRCL(3011,IPRAC,IS,IR)
      WRITE(LP,2000)
 2010 FORMAT(20H OUTPUT OPTIONS ARE:/
     1        22H   0  SELECT ALL UNITS/
     2        22H   1  SELECT CGS UNITS/
     3        21H   2  SELECT SI UNITS/
     4        26H   3  SELECT ENGLISH UNITS/
     5        24H   4  SELECT MIXED UNITS)
      CALL IRCL(3018,IPRRP,IS,IR)
      RETURN
C
 1000 FORMAT (/5X,30HOUTPUT CONTROL OPTIONS ARE .../)
      END
      OVERLAY(3,0)
      PROGRAM MODA
C
C          MODA OBTAINS THE NECESSARY INFORMATION FOR THE EXECUTION
C          OF SUBROUTINE RLJVI. RLJVI COMPUTES THE FLOW RATE
C          FOR EITHER LIQUIDS OR GASES AS A FUNCTION OF TIME
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      DIMENSION TIMEA(150),TEMP(150),FRT(150),PTA(150),TMGS(150),TMLS(15
     10)
      EQUIVALENCE (XBX(1),TIMEA(1))
      DATA MOD/4H  A /
      CALL TRACE(0,3,0)
    1 CONTINUE
      IERR=0
      ISC=6
C
C          OBTAIN FROM DATA BASE THE NECESSARY DATA ITEMS
C
      CALL BEGPR(MOD)
      CALL FRCL(1002,AM,ISC,IERR)
      CALL FRCL(1007,CPL,ISC,IERR)
      CALL FRCL(1010,AVP,ISC,IERR)
      CALL FRCL(1011,BVP,ISC,IERR)
      CALL FRCL(1012,CVP,ISC,IERR)
      CALL FRCL(1013,CPG,ISC,IERR)
      CPG=CPG/AM
      CALL FRCL(1014,HVAP,ISC,IERR)
      CALL FRCL(2001,VOL,ISC,IERR)
      CALL FRCL(2002, HT,ISC,IERR)
      CALL FRCL(2003, HH,ISC,IERR)
      ISC1=8
      IER1=0
      CALL FRCL(2004,TO,ISC1,IER1)
      IF(IER1.EQ.1) IERR=1
      IF(ISC1.LT.ISC) ISC=ISC1
      ISC2=8
      IER2=0
      CALL FRCL(2005,PTO,ISC2,IER2)
      IF(IER2.EQ.1) IERR=1
      IF(ISC2.LT.ISC) ISC=ISC2
      IF(TO.GE.15.) CALL FRCL(1004,DL,ISC,IERR)
      IF(TO.LT.15.) CALL FRCL(1021,DL,ISC,IERR)
      CALL IRCL(2006,IADBT,ISC,IERR)
      CALL FRCL(2007,AMSSO,ISC,IERR)
```

```
      CALL FRCL(2008,HOLED,ISC,IERR)
      CALL IRCL(2009,INC,ISC,IERR)
      CALL IRCL(3001,ITAB,IS,IR)
      CALL EPRNT(MOD,ISC,IERR,IFLAG)
      IF(IFLAG.EQ.1) GO TO 99
      IF(IFLAG.EQ.2) GO TO 1
C
C     IF THE INITIAL PRESSURE IN THE TANK IS GIVEN, IT WILL BE USED TO
C     FIND THE INITIAL TEMPERATURE OF THE CARGO.  IF THE TEMPERATURE IS
C     GIVEN BUT THE PRESSURE IS NOT, THE TEMPERATURE WILL BE USED.  IF
C     BOTH ARE NOT GIVEN, THE DEFAULT VALUE FOR TEMPERATURE WILL BE USED
      IF(ISC2.EQ.5) GO TO 3
      PTO=-1.
C
C         CALL RLJVI
C
    3 CALL RLJVI(VOL,HT,HH,HOLED,DL,PTO,AM,IADBT,TO,AMSSO,CPG,CPL,HVAP,
     1AVP,BVP,CVP,INC,INS,TIMEA,TEMP,FRT,PTA,TMGS,TMLS,TVL,TIMEG,TIMEL)
C
C     CALCULATE AVERAGE RATES OF GAS AND LIQUID RELEASE.
C
      GASRT=0.0
      RTLIQ=0.0
      IF(TIMEG.GT.0.0) GASRT=TMGS(INS)/TIMEG
      IF(TIMEL.GT.0.0) RTLIQ=TMLS(INS)/TIMEL
C
C         UPDATE DATA BASE WITH OUTPUT OF RLJVI
C
      CALL OUTPR(MOD)
      CALL PAGER(2)
      WRITE(LP,10)
      CALL FSV(4001,TMGS(INS),4)
      CALL FSV(4047,GASRT,4)
      CALL FSV(4048,TIMEG,4)
      AVTEM=(TEMP(1)+TEMP(INS))/2.
      CALL FSV(4068,AVTEM,2)
      CALL PAGER(2)
      WRITE(LP,11)
      CALL FSV(4002,TMLS(INS),4)
      CALL FSV(4003,TVL,4)
      CALL FSV(4049,RTLIQ,4)
      CALL FSV(4050,TIMEL,4)
      IF(TMLS(INS).LT.1.) GO TO 19
      CALL PAGER(2)
      WRITE(LP,18)
      IF(TIMEL.LT.600.) CALL ISV(2029,0,4)
      IF(TIMEL.LT.600.) CALL ISV(2058,0,4)
      IF(TIMEL.LT.600.) CALL ISV(2060,0,4)
      IF(TIMEL.GE.600.) CALL ISV(2029,1,4)
      IF(TIMEL.GE.600.) CALL ISV(2058,1,4)
      IF(TIMEL.GE.600.) CALL ISV(2060,1,4)
   19 IF(TMGS(INS).LT.1.) GO TO 21
      CALL PAGER(2)
      WRITE(LP,20)
      IF(TIMEG.LT.600.) CALL ISV(2061,0,2)
      IF(TIMEG.GE.600.) CALL ISV(2061,1,2)
      CALL FSV(4044,GASRT,2)
      CALL FSV(4045,TIMEG,2)
   21 CALL ENDPR(MOD)
      IF(ITAB.EQ.0) GO TO 99
      DO 25 II=1,2
      CALL PAGER(0)
      CALL PAGER(4)
      WRITE(LP,12)
      CALL PAGER(1)
      WRITE(6,13)
      IF(II.NE.1) GO TO 100
      CALL PAGER(3)
      WRITE(LP,14)
  100 CONTINUE
      IF(II.NE.2) GO TO 110
      CALL PAGER(3)
```

AD-A110 275 LITTLE (ARTHUR D) INC CAMBRIDGE MA F/G 9/2
DEVELOPMENT OF A HACS USER INTERFACE MODULE.(U)
SEP 81 R G POTTS DOT-CG-925331-A
UNCLASSIFIED USCG-D-74-81 NL

2 - 3


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5

```
      WRITE(LP,15)
  110 CONTINUE
      DO 16 I=1,INS
      IF(II.EQ.1) FLW=FRT(I)/1000.
      IF(II.EQ.1) TMG=TMGS(I)/1000.
      IF(II.EQ.1) TML=TMLS(I)/1000.
      IF(II.EQ.1) PRES=PTA(I)/1C.
      IF(II.EQ.2) FLW=FRT(I)/454.
      IF(II.EQ.2) TMG=TMGS(I)/454.
      IF(II.EQ.2) TML=TMLS(I)/454.
      IF(II.EQ.2) PRES=PTA(I)*0.000145077
      IF(II.EQ.1) TEM=TEMP(I)
      IF(II.EQ.2) TEM=(1.8*TEMP(I))+32.
      CALL PAGER(1)
      WRITE(LP,17) TIMEA(I),FLW,TMG,TML,TEM,PRES
   16 CONTINUE
   25 CONTINUE
      GO TO 99
   10 FORMAT(1X,16HFOR GAS VENTING /)
   11 FORMAT(/1X,19HFOR LIQUID VENTING /)
   12 FORMAT(1H ,/,35X,44HTABLE OF CHEMICAL VENTING PROCESS PARAMETERS//
     1)
   13 FORMAT(12X,11HTIME OF REL,5X,11HTOT FLWRATE,5X,11HTOT GAS REL,5X,
     111HTOT LIQ REL,6X,9HTANK TEMP,7X,9HTANK PRES)
  140FORMAT (15X,6H(SECS),9X,8H(KG/SEC),10X,4H(KG),12X,4H(KG),10X,
     1       7H(DEG C),9X,8H(N/SQ M)//)
  150FORMAT (15X,6H(SECS),9X,8H(LB/SEC),10X,4H(LB),12X,4H(LB),10X,
     1       7H(DEG F),8X,10H(LB/SQ IN)//)
   17 FORMAT (14X,F7.1,8X,G10.4,2(5X,G10.4),7X,F7.1,7X,G10.4)
  180FORMAT(/1X,62HTHE LIQUID DISCHARGE RATE AND DURATION LEADS TO THE
     1ASSUMPTION/1X,61HTHAT THE FOLLOWING SPILL DURATION INDICATORS ARE
     2APPROPRIATE.)
   20 FORMAT(/1X,62HIN CASE MODEL C DIRECTLY FOLLOWS, THE VAPOR DISCHARG
     *E DURATION/1X,26HINDICATOR IS ESTIMATED AS-)
   99 CONTINUE
      CALL TRACE(1,3,0)
      END
      FUNCTION RLJLQ(AMASS,VOL,HT,HH,X,DL)
C
C     THIS FUNCTION CALCULATES THE LIQUID LEVEL ABOVE THE HOLE
C
C     THIS ROUTINE IS NOT USED SEPARATELY AND THEREFORE REQUIRES NO
C          SPECIAL INPUTS
C
C
      VOLL=(1.-X)*AMASS/DL
      IF(VOLL-VOL*0.0001) 10,5,5
5     DZ=HT*VOLL/VOL-HH
      GO TO 15
10    DZ=-.01
15    RLJLQ=DZ
      RETURN
      END
      SUBROUTINE RLJTC(VOL,HT,HH,X,DL,DV,PT,PA,AK,AM,IADBT,T,AMASS,AMASO
     1,CPG,CPL,HVAP,AVP,BVP,CVP)
C
C     THIS SUBROUTINE, CALLED BY THE VENTING RATE INTEGRATION
C          SUBROUTINE, CALCULATES INSTANTANEOUS TANK CONDITIONS
C
C     THIS ROUTINE IS NOT USED SEPARATELY AND THEREFORE REQUIRES NO
C          SPECIAL INPUTS
C
      DATA R/84836.73469/
C.....CHECK WHETHER ISOTHERMAL OR ADIABATIC
      IF(IADBT)5,5,25
C.....CALCULATE TANK PRESSURE, VAPOR DENSITY, AND VAPOR WEIGHT FRACTION
C.....FOR ISOTHERMAL CASE
5     PT=AMASS*R*T/(AM*VOL)
      PF=RLJVP(T,AVP,BVP,CVP)
      IF(PF.LT.PA) PF=PA
      IF(PT-PF)10,10,15
10    DV=AM*PT/(R*T)
```

```
      X=1.
      GO TO 55
15    PT=PF
      DV=AM*PT/(R*T)
      X=(VOL*DV*DL/AMASS-DV)/(DL-DV)
      GO TO 55
C.....SEARCH FOR THE TANK TEMPERATURE
25    TL=T
27    TH=TL
      TL=TH-10.
      CALL RLJTS(TL,TC,PC,XC,VOL,HT,HH,X,DL,DV,PT,PA,AK,AM,T,AMASS,AMASO
     1,CPG,CPL,HVAP,AVP,BVP,CVP)
      IF(TL-TC)30,30,27
30    DO 45 I=1,10
      TS=(TH+TL)/2.
      CALL RLJTS(TS,TC,PC,XC,VOL,HT,HH,X,DL,DV,PT,PA,AK,AM,T,AMASS,AMASO
     1,CPG,CPL,HVAP,AVP,BVP,CVP)
      IF(TS-TC)40,50,35
35    TH=TS
      GO TO 45
40    TL=TS
45    CONTINUE
50    T=TS
      PT=PC
      X=XC
55    RETURN
      END
      SUBROUTINE RLJTS(TS,TC,PC,XC,VOL,HT,HH,X,DL,DV,PT,PA,AK,AM,T,AMASS
     1,AMASO,CPG,CPL,HVAP,AVP,BVP,CVP)
C
C     THIS SUBROUTINE, CALLED BY THE TANK CONDITION SUBROUTINE, USES A
C          PRESSURE-TEMPERATURE RELATIONSHIP, MASS BALANCE, AND AN
C          ENERGY BALANCE TO CALCULATE A TEMPERATURE FROM THE GIVEN ONE.
C          IF THE TWO ARE EQUAL THEN THE TEMPERATURE IS THE
C          SIMULTANEOUS SOLUTION TO THE EQUATIONS.
C
C     THIS ROUTINE IS NOT USED SEPARATELY AND THEREFORE REQUIRES NO
C          SPECIAL INPUTS
C
      DATA R/84836.73469/
C.....CHECKS TO SEE IF LIQUID IS PRESENT IN TANK
      PV=RLJVP(TS,AVP,BVP,CVP)
      PC=AMASS*R*TS/(AM*VOL)
      IF(PV-PC)10,10,5
C.....CALCULATES TC USING IDEAL GAS EXPANSION EQUATION
5     TC=T*(PC/PT)**((AK-1.)/AK)
      DV=AM*PC/(R*TS)
      XC=1.
      GO TO 25
C.....CALCULATES XC AND TC
10    PC=PV
      DV=AM*PC/(R*TS)
      XC=(VOL*DV*DL/AMASS-DV)/(DL-DV)
      SH=AMASS*(X*CPG+(1.-X)*CPL)
      IF(RLJLQ(AMASS,VOL,HT,HH,X,DL))20,15,15
   15 TC=T-(HVAP*(AMASS*XC-AMASO*X)+VOL*(PT-PC)/42680.)/SH
      GO TO 25
   20 TC=T-(HVAP*(AMASO*(1.-X)-AMASS*(1.-XC))+VOL*(PT-PC)/42680.)/SH
25    RETURN
      END
      SUBROUTINE RLJVI(VOL,HT,HH,HOLED,DL,PTO,AM,IADBT,TO,AMSSO,CPG,
     1CPL,HVAP,AVP,BVP,CVP,INC,INS,TIMEA,TEMP,FRT,PTA,TMGS,TMLS,TVL,TIME
     2G,TIMEL)
C
C     THIS SUBROUTINE INTEGRATES NUMERICALLY THE FLOW RATE AS A
C          FUNCTION OF TIME AND PRODUCES ARRAYS OF THE TIME,
C          TEMPERATURE, INSTANTANEOUS FLOW RATE, VAPOR WEIGHT FRACTION,
C          AND TANK PRESSURE AS A FUNCTION OF THE MASS FRACTION
C          RELEASED.
C
C ***** INPUTS
C
```

```
C       VOL     VOLUME OF TANK                                   CM**3
C       HT      HEIGHT OF TANK                                   CM
C       HH      HEIGHT OF HOLE                                   CM
C       HOLED   DIAMETER OF THE HOLE                             CM
C       DL      LIQUID DENSITY                                   GM/CM**3
C       AM      MOLECULAR WEIGHT OF THE CHEMICAL
C       IADBT   HEAT TRANSFER FLAG (IF POSITIVE, TANK IS ADIABATIC,
C                  OTHERWISE IT IS ISOTHERMAL
C       PTO     INITIAL TANK PRESSURE                            DYNES/CM**2.
C       TO      INITIAL TEMPERATURE OF TANK                      DEG C
C                NOTE- THE PROGRAM DOES NOT REQUIRE BOTH THE PRESSURE
C                AND TEMPERATURE AS INPUT.  IF THE PRESSURE IS GIVEN, IT
C                WILL BE USED. IF THE TEMPERATURE IS GIVEN, THE INPUT
C                FOR PRESSURE SHOULD BE SET AT SOME NEGATIVE VALUE.
C       AMSSO   INITIAL MASS IN TANK                             GMS
C       CPG     HEAT CAPACITY OF VAPOR                           CAL/GM-DEG C
C       CPL     HEAT CAPACITY OF LIQUID                          CAL/GM-DEG C
C       HVAP    HEAT OF VAPORIZATION                             CAL/GM
C       AVP,BVP,CVP-CONSTANTS FOR A VAPOR PRESSURE EQUATION WHICH GIVES
C                  AN ANSWER IN MM HG.  THE FORM OF THE EQUATION IS
C                  VAPOR PRESSURE=10.**(AVP-(BVP/(T+CVP)))
C                  WHERE T IS THE TEMPERATURE IN DEG C
C       INC     NUMBER OF MASS INCREMENTS PROGRAM IS DESIRED TO RUN FOR
C                  (MAXIMUM ALLOWED IS 150)
C
C *** OUTPUTS
C
C       INS      AN INTEGER INDICATING THE NUMBER OF MASS INCREMENTS
C                WHICH WERE RELEASED.
C       TIMEA   ARRAY OF TIMES                                   SEC
C       TEMP    ARRAY OF TANK TEMPERATURES                       DEG C
C       FRT     ARRAY OF FLOW RATES                              GM/SEC
C       PTA     ARRAY OF TANK PRESSURES                          DYNES/CM**2.
C       TMGS    ARRAY OF TOTAL MASS GAS RELEASED                 GM
C       TMLS    ARRAY OF TOTAL MASS LIQUID RELEASED              GM
C       TVL     VOLUME OF LIQUID RELEASED                        CM**3
C       TIMEG   TIME OVER WHICH GAS DISCHARGED                   SECS
C       TIMEL   TIME OVER WHICH LIQUID DISCHARGED                SECS
C
      ODIMENSION TIMEA(150),TEMP(150),FRT(150),PTA(150),TMLS(150),
      1          TMGS(150)
       DATA PA/1033.92857/
       DATA R/84836.73469/
C ****  PA IS EQUAL TO ONE STANDARD ATMOSPHERE IN GMF/CM**2 UNITS.
C  ***   R IS THE UNIVERSAL GAS CONSTANT IN GMF CM/MOLE DEG K UNITS.
C.....INITIALIZE
       PI=3.14159265
       RP=1.986
       AK=1./(1.-(RP/(AM*CPG)))
       A=PI*((HOLED/2.)**2.)
       TMG=0.
       TML=0.
       TIMEG=0.0
       TIMEL=0.0
       TVL=0.
       TIME=0.000
       CO=.8
       PT=PTO/980.7
       IF(PT) 2,2,1
     1 TO=(BVP/(AVP-ALOG10(0.7356*PT)))-CVP+273.16
       T=TO
       TO=T-273.16
       GO TO 4
     2 T=TO+273.16
       PT=RLJVP(T,AVP,BVP,CVP)
     4 DV=AM*PT/(R*T)
       IF(INC-150)5,10,10
5      INCC=INC
       GO TO 15
10     INCC=150
    15 AMAS=AMSSO/FLOAT(INCC)
       AMASS=AMSSO
```

```
      X=(VOL*DV*DL/AMASS-DV)/(DL-DV)
      CALL VENTR(CO,AMASS,VOL,HT,HH,X,A,DL,DV,PT,PA,AK,AM,T,IFLAG,W)
      FR=W
C.....START MASS RELEASE LOOP
      DO 20 INS=1,INCC
C.....CALCULATE FLOW RATE AND TANK CONDITIONS
      AMASO=AMASS
      IF(INS .EQ. INCC)AMAS=AMAS*.99
      AMASS=AMASS-AMAS
      CALL RLJTC(VOL,HT,HH,X,DL,DV,PT,PA,AK,AM,IADBT,T,AMASS,AMASO,CPG,
     1CPL,HVAP,AVP,BVP,CVP)
      CALL VENTR(CO,AMASS,VOL,HT,HH,X,A,DL,DV,PT,PA,AK,AM,T,IFLAG,W)
      AVGFR=(W+FR)/2.
      IF(AVGFR.LE.0.0) GO TO 30
      DT=AMAS/AVGFR
      FR=W
      TIME=TIME+DT
C.....CHECK TO SEE IF FLOW HAS STOPPED
      IF(PT-PA)16,18,18
16    AL=RLJLQ(AMASS,VOL,HT,HH,X,DL)
      IF(AL)30,30,17
17    IF(PT-PA+AL*DL)30,18,18
C.....SAVE VALUES
   18 IF(IFLAG-1)30,40,50
   40 TML=TML+AMAS
      TIMEL=TIMEL+DT
      GO TO 60
   50 TMG=TMG+AMAS
      TIMEG=TIMEG+DT
   60 TIMEA(INS)=TIME
      TEMP(INS)=T-273.16
      FRT(INS)=FR
      PTA(INS)=PT*980.7
      TMGS(INS)=TMG
      TMLS(INS)=TML
20    CONTINUE
      INS = INCC
      GO TO 31
30    INS=INS-1
   31 TVL=TML/DL
      RETURN
      END
      FUNCTION RLJVP(T,AVP,BVP,CVP)
C
C     THIS FUNCTION CALCULATES THE VAPOR PRESSURE OF THE
C          MATERIAL INSIDE THE TANK
C
C     THIS ROUTINE IS NOT USED SEPARATELY AND THEREFORE REQUIRES NO
C          SPECIAL INPUTS
C
      RLJVP=(10.**(AVP-(BVP/(T-273.16+CVP))))/.7356
      RETURN
      END
      SUBROUTINE VENTR(CO,AMASS,VOL,HT,HH,X,A,DL,DV,PT,PA,AK,AM,T,IFLAG,
     1W)
C
C     THIS ROUTINE, CALLED BY THE VENTING RATE INTEGRATION SUBROUTINE,
C             CALCULATES INSTANTANEOUS VENTING RATES (GM/SEC)
C
C
C     THIS ROUTINE IS NOT USED SEPARATELY AND THEREFORE REQUIRES NO
C          SPECIAL INPUTS
C
      DATA R/84836.73469/
      DATA G/980./
C.....CHECK WHETHER LIQUID OR GAS IS BEING VENTED.
      DZ=RLJLQ(AMASS,VOL,HT,HH,X,DL)
      IF(DZ) 10,10,5
C.....CALCULATE LIQUID VENTING RATE
C---CODE REVISIONS INSERTED 7 APRIL 1978
    5 ARG=2.*DL*G*(PT-PA+DL*DZ)
      CALL SRTCK(ARG,1)
      W=CO*A*SQRT(ARG)
```

```
      IFLAG=1
      RETURN
C.....CHECK WHETHER GAS FLOW IS CHOKED
10    IF(PA/PT-(2./(AK+1.))**(AK/(AK-1.)))15,15,20
C.....CALCULATE THE GAS CHOKED FLOW VENTING RATE
   15 ARG=AM*G/R
      CALL SRTCK(ARG,2)
      ARGB=AK*(2./(AK+1.))**((AK+1.)/(AK-1.))
      CALL SRTCK(ARGB,3)
      ARGC=T
      CALL SRTCK(ARGC,4)
      W=CO*SQRT(ARG)*SQRT(ARGB)*PT*A/SQRT(ARGC)
      IFLAG=2
      RETURN
C.....CALCULATE THE GAS NON-CHOKED FLOW VENTING RATE
20    B=PA/PT
      IF(B-1.) 21,22,22
   21 ARG=B**(2./AK)*AK/(AK-1.)*(1.-B**((AK-1.)/AK))/(1.-B)
      CALL SRTCK(ARG,5)
      ARGB=2.*G*(PT-PA)*DV
      CALL SRTCK(ARGB,6)
      W=CO*SQRT(ARG)*A*SQRT(ARGB)
      GO TO 23
22    W=0.
23    IFLAG=2
   25 RETURN
      END
      SUBROUTINE SRTCK(ARG,N)
C
C  SPECIAL SQUARE ROOT ARGUMENT TEST ROUTINE INSERTED BY
C  R.G. POTTS ON 7 APRIL 1978.  IF ARGUMENT IS LESS THAN
C  0.0, THE ROUTINE GENERATES A WARNING MESSAGE THEN
C  SUBSTITUTES A VALUE OF 0.0 ON RETURN.  THE INTEGER
C  N IS A LOCATION REFERENCE TO THE CALLING PROGRAM.
C  REFERENCES 1 TO 6 ARE USED BY SUBROUTINE VENTR.
C
      COMMON/HEAD/DTE,LNCT,LNPG,LP,NPG,TITLE(10)
C
      IF(ARG.GE.0.0) RETURN
      CALL PAGER(2)
      WRITE(LP,1000) ARG,N
      ARG=0.0
      RETURN
 1000 FORMAT (5X,38H*****WARNING, SQUARE ROOT ARGUMENT OF ,G13.4/
     1        10X,36H WAS SET TO 0.0 AT PROGRAM LOCATION ,I2)
      END
      OVERLAY(4,0)
      PROGRAM OV4
C
C         OV4 EXECUTES THE FOLLOWING INTER-RELATED GROUP OF FLAME SIZE
C         AND THERMAL RADIATION RATE MODELS -
C
C                   RATE MODEL  =  B    INDEX  =  2
C                                  E              5
C                                  H              8
C                                  L             12
C                                  Q             17
C                                  U             21
C
C         H       = DUMMY INTERNAL VARIABLE USED TO TRANSFER VALUE OF
C                     FIELD 4018 TO FIELD 4006
C         IR      = ERROR VALUE RETURNED BY FRCL ROUTINE
C         IS      = VALUE OF SOURCE CODE UPDATED IN FRCL, NOT USED IN
C                     PROGRAM OV4
C
C         COMMON VARIABLES USED - MODNO
C
C         SUBROUTINES REQUIRED  - FRCL,FSV,MODB1,MODB2,MODE1,MODE2,MODH,
C                                 MODL,MODQ,MODU,TRACE
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                              35/309A ACORN PARK,
```

```
C                                    CAMBRIDGE, MASS., 02140
C                                    TEL. 617-864-5770  EXT. 2813
C          DATE    - 8 JANUARY 1976
C
C
      COMMON/OVCNT/MODNO,OVLST(29),SGLST(29)
      INTEGER       OVLST,SGLST
C
C
C--------PRINT OVERLAY EXECUTION TRACE MESSAGE, THEN BRANCH ON MODEL
C         INDEX NUMBER
      CALL TRACE(0,4,0)
C
C--------SELECT MODEL B
      IF(MODNO.NE.2) GO TO 10
      CALL MODB1
      CALL MODB2
      GO TO 100
C
C--------SELECT MODEL E
   10 IF(MODNO.NE.5) GO TO 20
      CALL MODE1
      CALL MODE2
      CALL FRCL(4018,H,IS,IR)
      CALL FSV(4006,H,6)
      CALL MODB2
      GO TO 100
C
C--------SELECT MODEL H
   20 IF(MODNO.NE.8) GO TO 30
      CALL MODH
      GO TO 100
C
C--------SELECT MODEL L
   30 IF(MODNO.NE.12) GO TO 40
      CALL MODL
      GO TO 100
C
C--------SELECT MODEL Q
   40 IF(MODNO.NE.17) GO TO 50
      CALL MODQ
      GO TO 100
C
C--------SELECT MODEL U
   50 IF(MODNO.NE.21) GO TO 100
      CALL MODU
C
C--------PRINT OVERLAY EXECUTION TRACE MESSAGE, THEN RETURN TO MAIN
C         HACS CONTROL
  100 CALL TRACE(1,4,0)
C
      END
      FUNCTION ARSIN(A)
C
C           ARSIN COMPUTES THE ARC SINE OF AN ANGLE WHOSE SINE IS GIVEN
C           ARGUMENTS --
C           A = SINE OF THE ANGLE
C           ARSIN = THE ANGLE WHOSE SINE IS A
C
      B=SQRT(1.-A**2)
      IF(B.NE.0.) GO TO 1
      ARSIN=0.
      CALL PAGER(2)
      WRITE(6,100)
      RETURN
    1 ARSIN=ATAN(A/B)
      RETURN
  100 FORMAT(23H ERROR IN ARSIN ROUTINE/)
      END
      SUBROUTINE CVERT(D,IOUT)
C
C     THIS ROUTINE CONVERTS UNITS OF INPUT AND OUTPUT DATA TO PROPER
```

```
C     UNITS FOR USE BY ROUTINE PROTNK.
C
C  *** INPUTS AND OUTPUTS ***
C
C     D         ARRAY OF INPUT AND OUTPUT DATA FROM ROUTINE PROTNK
C               ( SEE HEADING OF PROTNK FOR DEFINITIONS)
C     IOUT      INDICATOR FLAG.  WHEN IOUT=1, CVERT CONVERTS DATA
C               FROM CGS TO ENG UNITS.  WHEN IOUT=2, IT CONVERTS
C               FROM ENG UNITS TO CGS UNITS.
C
      DIMENSION D(26),C(5)
C
C     DIVISION BY C(1) CONVERTS UNITS FROM CM TO FEET
      C(1)=30.48
C     DIVISION BY C(2) CONVERTS UNITS FROM CM TO INCHES
      C(2)=2.54
C     DIVISION BY C(3) CONVERTS UNITS FROM DYNES/CM**2 TO PSI
      C(3)=68975.72
C     DIVISION BY C(4) CONVERTS UNITS FROM CAL/SEC-CM2 TO BTU/HR-FT2
      C(4)=0.0000753474
C     DIVISION BY C(5) CONVERTS UNITS FROM CAL/SEC-CM-DEG C TO
C     BTU/HR-FT-DEG F
      C(5)=0.0041339
C
      IF(IOUT.EQ.1) GO TO 5
      DO 3 I=1,5
    3 C(I)=1./C(I)
    5 D(1)=D(1)/C(1)
      D(2)=D(2)/C(2)
      D(4)=D(4)/C(3)
      D(5)=D(5)/C(4)
      DO 10 I=6,10
   10 D(I)=D(I)/C(5)
      DO 20 I=16,20
   20 D(I)=D(I)/C(3)
      IF(IOUT.EQ.1) GO TO 30
      D(22)=D(22)/C(3)
      D(23)=(D(23)-32.)*(5./9.)
      D(24)=D(24)/C(3)
      D(25)=(D(25)-32.)*(5./9.)
      D(26)=D(26)*60.
   30 RETURN
      END
      SUBROUTINE FLJET(HOLED,XMOL,TADIA,ALPHA,AFR,XLEN,DE)
C
C *** THIS ROUTINE CALCULATES THE FLAME LENGTH AND DIAMETER (OF AN
C       EQUIVALENT CYLINDRICAL FLAME) FOR A NON-PREMIXED TURBULENT
C     FLAME BASED ON HOTTELS ANALYSIS OF TURBULENT FLAMES.  THE
C     FLAME PARAMETERS ARE FAIRLY INSENSITIVE TO THE PRESSURE IN THE
C     TANK.
C  ******************************************************************
CC *********** INPUT ARGUMENTS ****************
C *** HOLED   DIAMETER OF HOLE IN THE TANK        CMS
C *** XMOL    MOLECULAR WEIGHT OF FUEL            GMS/MOL
C *** TADIA   ADIABATIC FLAME TEMPERATURE         DEG C
C *** ALPHA   MOLAR RATIO OF REACTANTS TO PRODUCTS
C *** AFR     STOICHIOMETRIC AIR FUEL RATIO       GM OF AIR/GM OF FUEL
C             FOR STOICHIOMETRIC COMBUSTION
C ************ OUT PUT ARGUMENTS ************
C *** XLEN    LENGTH OF FLAME                     CMS
C *** DE      DIAMETER OF EQUIVALENT CYLINDRICAL          CMS
C             FLAME (FOR USE IN THERMAL RADIATION MODELS).
      TF=TADIA+273.
      CT=1./(1.+AFR*XMOL/28.9)
      RHS=(5.3/CT)*SQRT((CT+(1.-CT)*28.9/XMOL)*(TF/(ALPHA*300.)))
C ***  300 DEG KELVIN IS USED FOR AMBIENT TEMPERATURE.
C ***  SEMI ANGLE OF JET IS ASSUMED TO BE 5.4 DEGREES.
      XLEN=HOLED*RHS
      DE=HOLED+XLEN/10.6
      RETURN
      END
      SUBROUTINE FLMAN(D,PG,UW,ALPHA)
```

```
C
C**********************************************************************
C         THIS SUBROUTINE CALCULATES THE FLAME ANGLE WITH THE VERTICAL
C         USING THE MODEL OF SLIEPCEVICH, WELKER, HUFFMAN, AND PIPKIN,
C
C*****  INPUT ARGUMENTS ****
C    D          POOL DIAMETER                          CMS
C    PG         FUEL VAPOR DENSITY AT THE TEMP OF LIQUID.    GM/CM**3
C    UW         WIND VELOCITY                                CM/SEC
C
C******  OUTPUT ARGUMENT *****
C    ALPHA      FLAME ANGLE WITH RESPECT TO THE VERTICAL     RADIANS
C
C**********************************************************************
C
      ALPHA=0.
      IF(UW.LE.0.) RETURN
      TC=3.3*((D*UW/0.15)**0.07)*((UW**2/(980.*D))**0.8)*((PG/1.2E-3)**
     1(-0.6))
C
C ***  0.15 IS THE KINEMATIC VISCOSITY OF AIR IN CM**2/SEC
C ***  1.2E-3 IS THE DENSITY OF AIR IN GM/CM**3
      ALPHA=ARSIN((-1.+SQRT(1.+4.*TC**2))/(2.*TC))
      RETURN
      END
      SUBROUTINE FLMHT(DIA,D,R,H)
C
C     THIS ROUTINE CALCULATES THE FLAME HEIGHT (CM) OF A POOL FIRE
C          USING THOMAS=S MODEL.
C
C     ARGUMENTS
C          DIA   POOL DIAMETER,CM
C          D     DENSITY OF LIQUID FUEL, GM/CU CM
C          R     THE BURNING RATE IN CM/SEC
C          H     FLAME HEIGHT,CM
C
      H=DIA*42.*(R*D/(1.2E-3*SQRT(980.*DIA)))**.61
      RETURN
      END
      SUBROUTINE JHHRF(DIA,H,S,ALPHA,T,HF)
C
C     THIS ROUTINE CALCULATES THE MAXIMUM RADIATION FLUX POSSIBLE FROM
C      A FLAME OF GIVEN CHARACTERISTICS AT A GIVEN DISTANCE FROM THE
C       CENTER OF THE BASE OF THE FLAME
C     SOLAR INSULATION=300 BTU/HR-SQ FT.
C
C ****  INPUT ARGUEMENTS
C     T         FLAME TEMPERATURE,DEGREES C
C     DIA       DIAMETER OF THE BURNING POOL,CM
C     H         HEIGHT OF THE FLAME,CM
C     S         DISTANCE OF THE OBSERVER FROM CENTER OF BASE OF FLAME,CM
C     ALPHA     ANGLE OF PLUME FROM VERTICAL,RADIANS
C
C ***  OUTPUT ARGUEMENTS
C     HF        RADIATION FLUX,CAL/SEC-SQ CM
C
      PI=3.14159265
      S=S/(2.54*12.)
      ST=T
      H=H/(2.54*12.)
      T=460.+((9./5.)*T)+32.
      DIA=DIA/(2.54*12.)
      SB=.1713E-08
      EM=1.
      TR=1.
      EMPWR=SB*TR*EM*(T**4.)
      CALL SVEIW(ALPHA,H,S,DIA,FMAX)
      HF=(FMAX*EMPWR)+300.
      HF=HF*(252./(3600.*144.*2.54*2.54))
      T=ST
      DIA=DIA*(2.54*12.)
      S=S*(2.54*12.)
```

```
      H=H*2.54*12.
      RETURN
      END
      SUBROUTINE MODB1
C
C
C     SUBROUTINE MODB1 IS A MODULE OF MODEL B.  IT OBTAINS THE NECESSARY
C     DATA TO CALL ROUTINE FLJET, THE ROUTINE WHICH COMPUTES THE FLAME
C     LENGTH AND EQUIVALENT DIAMETER WHEN A GAS VENTING FROM A TANK IS
C     IGNITED AT ITS SOURCE
      DATA MOD/4H B1 /
    1 CONTINUE
      IR=0
      IS=6
C
C         OBTAIN NECESSARY DATA ITEMS
C
      CALL BEGPR(MOD)
      CALL FRCL(2008,HOLED,IS,IR)
      CALL FRCL(1002,XMOL,IS,IR)
      CALL FRCL(1016,TADIA,IS,IR)
      CALL FRCL(1017,ALPHA,IS,IR)
      CALL FRCL(1018,AFR,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
C
C         CALL FLJET AND UPDATE DATA BASE WITH OUTPUT FROM FLJET
C
      CALL FLJET(HOLED,XMOL,TADIA,ALPHA,AFR,XLEN,DE)
      CALL OUTPR(MOD)
      CALL FSV(4006,XLEN,4)
      CALL FSV(4007,DE,4)
C
C     AUDIT
C
      CALL ENDPR(MOD)
   99 RETURN
      END
      SUBROUTINE MODB2
C
C     SUBROUTINE MODB2 IS PART OF MODELS B AND E.  IT CALCULATES SAFE
C     SEPARATION DISTANCES FROM FLAMES AND THE RADIATION FLUX VS
C     DISTANCE FROM THE FLAME USING SUBROUTINE JHHRF
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      DIMENSION AS(20),AH(20),SAFSP(4),HTFLX(4),ASAV(20)
      DIMENSION PTITL(6),XTITL(6),XTITL1(6),YTITL(6)
      EQUIVALENCE (XBX(41),AS(1)),(XBX(1),AH(1))
      EQUIVALENCE (XBX(21),ASAV(1)),(XBX(61),SAFSP(1))
     0DATA (PTITL (I),I=1,6)/8HRADIATIO,8HN FLUX V,8HS DISTAN,
     18HCE - MOD,8HEL B    ,1H /
     0DATA (XTITL (I),I=1,6)/8HDISTANCE,8H FROM FL,8HAME CENT,
     18HER......,8H........,8H(METERS)/
     0DATA (XTITL1(I),I=1,6)/8HDISTANCE,8H FROM FL,8HAME CENT,
     18HER......,8H........,8H..(FEET)/
     0DATA (YTITL (I),I=1,6)/8HRADIATIO,8HN FLUX  ,8H (CAL/CM,
     18H2-S)    ,1H ,1H /
      DATA MOD/4H B2 /
      DATA HTFLX(1),HTFLX(2),HTFLX(3)/0.753,0.113,0.0339/
  100 CONTINUE
      IR=0
      IS=6
      LP=6
C
C         OBTAIN NECESSARY DATA ITEMS FOR JHHRF
C
      CALL BEGPR(MOD)
      CALL IRCL(2082,ITKHT,IS,IR)
      IF(ITKHT.GT.0) CALL FRCL(2083,TKDIS,IS,IR)
      CALL FRCL(1019,T,IS,IR)
```

```
      CALL FRCL(4006,H,IS,IR)
      CALL FRCL(4007,DIA,IS,IR)
      CALL FRCL(4008,ALPHA,IS,IR)
      IF(ITKHT.EQ.1) GO TO 101
      IERR=0
      CALL FRCL(2010,HTFLX(4),IS,IR)
      IF(HTFLX(4).GT.0.0.AND.HTFLX(4).LE.0.0226) IERR=1
      CALL IRCL(3003,IB2SF,IS,IR)
  101 CONTINUE
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 100
      IF(DIA.LE.0.0) CALL PAGER(4)
      IF(DIA.LE.0.0) WRITE(LP,96)
      IF(DIA.LE.0.0) GO TO 99
      IF(ITKHT.EQ.1) GO TO 97
C
C     ITERATION TO FIND SAFE SEPARATION DISTANCES
C     SAFE SEPARATION DISTANCES CALCULATED ARE ONLY ACCURATE TO
C     WITHIN 10 FEET.
C     THE MINIMUM DISTANCE WHICH CAN BE AN OUTPUT IS 5 FEET.
C
      SAFSP(4)=0.0
      DISMN=DIA/2.
      IF(IERR.EQ.1) HTFLX(4)=0.0
      DO 50 ITER=1,4
      S=DISMN+(10.*2.54*12.)
      ISTP=0
      IF(HTFLX(ITER).EQ.0.0) GO TO 50
   15 CALL JHHRF(DIA,H,S,ALPHA,T,HF)
      IF(HF-HTFLX(ITER)) 20,25,30
   20 S=S-(10.*2.54*12.)
      IF(S.LE.DISMN) S=DISMN+(5.*2.54*12.)
      ISTP=1
      IF(S.EQ.(DISMN+(5.*2.54*12.)))GO TO 25
      GO TO 15
   25 SAFSP(ITER)=S-DISMN
      GO TO 50
   30 IF(ISTP.EQ.1) GO TO 25
      S=S+(100.*12.*2.54)
      GO TO 15
   50 CONTINUE
C
C         UPDATE DATA BASE WITH OUTPUT FROM JHHRF
C
      CALL OUTPR(MOD)
C
C     SAFE SEPARATION DISTANCES ARE MEASURED FROM THE EDGE OF
C     THE FLAME.
C
      CALL FSV(4009,SAFSP(1),4)
      CALL FSV(4015,SAFSP(2),4)
      CALL FSV(4017,SAFSP(3),4)
      IF(SAFSP(4).NE.0.0) CALL FSV(4034,SAFSP(4),4)
      CALL PAGER(2)
      WRITE(LP,51)
      IF(IERR.NE.1) GO TO 55
      CALL PAGER(2)
      WRITE(6,40)
   55 CONTINUE
      CALL ENDPR(MOD)
      IF(IB2SF.NE.1) GO TO 1
C
C         CALL JHHRF TO OBTAIN RADIATION FLUX AS A FUNCTION OF
C         REQUESTED DISTANCE
C
      SMX=DISMN+SAFSP(3)
      SMN=DISMN+SAFSP(1)
      AX=(SMX-SMN)/19.
      AS(1)=SMN
      CALL JHHRF(DIA,H,AS(1),ALPHA,T,AH(1))
      DO 10 I=2,20
```

```
      AS(I)=AS(I-1)+AX
      CALL JHHRF(DIA,H,AS(I),ALPHA,T,AH(I))
C
C         WRITE PLOT FILE INFORMATION
   10 CONTINUE
      DO 35 I=1,20
   35 ASAV(I)=AS(I)/100.
      DIV=1./3.281
      CALL PLTLP(PTITL,ASAV,AH,20,XTITL,YTITL,1,DIV,XTITL1)
C
C--------SET UP OFF-LINE PLOT
      PLTYP=2
C
    1 CONTINUE
      IF(ITKHT.EQ.0) GO TO 99
   97 CALL JHHRF(DIA,H,TKDIS,ALPHA,T,RDFLX)
      CALL PAGER(5)
      WRITE(6,98)
      CALL FSV(2066,RDFLX,4)
      CALL MODB3
   99 RETURN
  400FORMAT (/1X,61HTHE USER GIVEN RADIATION FLUX IS LESS THAN THAT FRO
     1M THE SUN./1X,51HTHE MODEL IS THEREFORE NOT EXECUTED FOR THIS VALU
     2E.)
   51 FORMAT(5X,47H*** SAFE SEPARATION DISTANCES ARE MEASURED FROM/9X,27
     1HTHE OUTER EDGE OF THE FLAME)
  960FORMAT(/5X,74H**** MODEL CANNOT BE EXECUTED FOR A ZERO OR NEGATIVE
     1 POOL DIAMETER.    ****/5X,34H**** EXECUTION IS TERMINATED. ****/)
   98 FORMAT(/61H EXECUTION OF THE COMPRESSED LIQUEFIED GAS TANK HEATING
     1 MODEL/62H HAS BEEN REQUESTED.  THE FOLLOWING OBTAINS THE NECESSAR
     2Y DATA/25H AND EXECUTES THIS MODEL./)
      END
      SUBROUTINE MODB3
C
C     THIS SUBROUTINE OBTAINS THE DATA NECESSARY FOR AND EXECUTES THE
C     COMPRESSED LIQUEFIED GAS TANK HEATING MODEL.  INPUTS AND OUTPUTS
C     ARE DESCRIBED IN THE HEADING FOR SUBROUTINE PROTNK.
C
      DIMENSION D(26)
      DATA MOD/4H B3 /
    1 CONTINUE
      LP=6
      CALL BEGPR(MOD)
      IS=6
      IR=0
      CALL FRCL(1010,AVP,IS,IR)
      CALL FRCL(1011,BVP,IS,IR)
      CALL FRCL(1012,CVP,IS,IR)
      DO 10 I=1,20
      II=I+2061
   10 CALL FRCL(II,D(I),IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
      CALL PROTNK(D,AVP,BVP,CVP)
      II=D(21)
      CALL OUTPR(MOD)
      IF(II.NE.1) GO TO 5
      CALL PAGER(3)
      WRITE(LP,40)
      CALL FSV(4051,D(22),4)
      CALL FSV(4052,D(23),4)
    5 IF(II.NE.2) GO TO 6
      CALL PAGER(3)
      WRITE(LP,30)
      CALL FSV(4053,D(24),4)
      CALL FSV(4054,D(25),4)
    6 IF(II.NE.3) GO TO 7
      CALL PAGER(3)
      WRITE(LP,20)
    7 IF(II.EQ.1.OR.II.EQ.2) CALL FSV(4055,D(26),4)
      CALL ENDPR(MOD)
```

```
   99 RETURN
   20 FORMAT(/39H *** FAILURE OF TANK DOES NOT OCCUR ***/)
   30 FORMAT(/49H *** FAILURE OF TANK OCCURS AT INSIDE OF WALL ***/)
   40 FORMAT(/50H *** FAILURE OF TANK OCCURS AT OUTSIDE OF WALL ***/)
      END
      SUBROUTINE MODE1
C
C         SUBROUTINE MODE1 IS PART OF MODEL E. IT OBTAINS THE NECESSARY
C         DATA TO EXECUTE FLMHT, WHICH CALCULATES FLAME HEIGHT OF A
C         POOL FIRE
      DATA MOD/4H E1 /
    1 CONTINUE
      IR=0
      IS=6
C
C        OBTAIN DATA
C
      CALL BEGPR(MOD)
      CALL FRCL(4007,DIA,IS,IR)
      CALL FRCL(1021,D,IS,IR)
      CALL FRCL(1015,R,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
C
C         CALL FLMHT. THEN UPDATE DATA BASE.
      CALL FLMHT(DIA,D,R,H)
C
      CALL OUTPR(MOD)
      CALL FSV(4018,H,4)
      CALL ENDPR(MOD)
   99 RETURN
      END
      SUBROUTINE MODE2
C
C
C         SUBROUTINE MODE2 IS PART OF MODEL E. IT OBTAINS THE NECESSARY
C         DATA TO EXECUTE FLMAN, WHICH CALCULATES THE FLAME ANGLE
C         FROM THE VERTICAL
      DATA MOD/4H E2 /
    1 CONTINUE
      IR=0
C
C        OBTAIN DATA
C
      CALL BEGPR(MOD)
      IS=6
      CALL FRCL(4007,D,IS,IR)
      CALL FRCL(2016,UW,IS,IR)
      CALL FRCL(1002,AM,IS,IR)
      CALL FRCL(1003,TB,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
      CALL COMPG(AM,TB,PG)
      CALL FSV(1009,PG,4)
      CALL FRCL(1009,PG,IS,IR)
C
C         CALL FLMAN AND THEN UPDATE DATA BASE
C
      CALL FLMAN(D,PG,UW,ALPHA)
      CALL OUTPR(MOD)
      CALL FSV(4008,ALPHA,4)
      CALL ENDPR(MOD)
   99 RETURN
      END
      SUBROUTINE MODH
C
C     SUBROUTINE MODH CALLS THE THERMAL RADIATION ROUTINES OF MODEL E
C     FOR SPILLS OF HEAVIER-THAN-WATER, FLAMMABLE OR COMBUSTIBLE
C     LIQUIDS WHICH HAVE A BOILING POINT LESS THAN AMBIENT  TEMPERATURE.
C     IN DOING SO, IT ESTIMATES THE DIAMETER OF THE BASE OF THE FLAME
```

```
C     AND TRANSFERS THE VALUE FOR THE HEIGHT OF THE FLAME (COMPUTED
C     IN MODE1) FROM FIELD NUMBER 4018 TO 4006.
C
C
      CALL PAGER(2)
      WRITE(6,100)
      CALL FRCL(4003,VOL,IS,IR)
      D=2.*VOL**(1./3.)
      CALL PAGER(2)
      WRITE(6,102)
      CALL FSV(4007,D,4)
      CALL MODE1
      CALL MODE2
      CALL FRCL(4018,H,IS,IR)
      CALL FSV(4006,H,6)
      CALL MODB2
      CALL PAGER(2)
      WRITE(6,101)
      RETURN
  100 FORMAT(82H MODEL H WILL BE REPLACED BY THE EXECUTION OF E1,E2, AND
     1B2 - EXECUTION PROCEEDING./)
  101 FORMAT(18H MODEL H EXECUTED./)
  102 FORMAT(123H MODEL H ASSUMES THAT THE DIAMETER OF THE FLAME IS TWIC
     *E THE VOLUME OF THE LIQUID DISCHARGED TO THE 1/3 POWER. THEREFORE.
     *../)
      END
      SUBROUTINE MODL
C
C     SUBROUTINE MODL CALLS THE THERMAL RADIATION ESTIMATION ROUTINES
C     OF MODEL E FOR SPILLS OF SOLUBLE, FLAMMABLE OR COMBUSTIBLE LIQUIDS
C     WHICH HAVE A BOILING POINT LESS THAN THE AMBIENT.  IN DOING SO,
C     IT ESTIMATES THE DIAMETER OF THE BASE OF THE FLAME AND
C     TRANSFERS THE VALUE FOR THE HEIGHT OF THE FLAME (COMPUTED IN
C     MODE1) FROM FIELD NUMBER 4018 TO 4006.
C
C
      CALL PAGER(2)
      WRITE(6,100)
      CALL FRCL(1021,DENL,IS,IR)
      CALL FRCL(2021,H,IS,IR)
      CALL FRCL(4003,VOL,IS,IR)
      D=2.*VOL**0.333333
      IF(H.LT.304.8.AND.DENL.LT.1.0) D=24.*VOL**0.333333
      CALL PAGER(2)
      WRITE(6,102)
      CALL FSV(4007,D,2)
      CALL MODE1
      CALL MODE2
      CALL FRCL(4018,H,IS,IR)
      CALL FSV(4006,H,6)
      CALL MODB2
      CALL PAGER(2)
      WRITE(6,101)
      RETURN
  100 FORMAT(85H MODEL L IS REPLACED BY THE EXECUTION OF MODELS E1,E2, A
     1ND B2 - EXECUTION PROCEEDING./)
  101 FORMAT(18H MODEL L EXECUTED./)
  102 FORMAT(5X,55HMODEL L ESTIMATES THE BURNING POOL DIAMETER AS BEING.
     1../)
      END
      SUBROUTINE MODQ
C
C     SUBROUTINE MODQ CALLS THE THERMAL RADIATION ESTIMATION ROUTINES
C     OF MODEL E FOR SPILLS OF SOLUBLE,FLAMMABLE OR COMBUSTIBLE LIQUIDS.
C     IN DOING SO, IT ESTIMATES THE DIAMETER OF THE BASE OF FLAME
C     AND TRANSFERS THE VALUE FOR THE HEIGHT OF THE FLAME (COMPUTED
C     IN MODE1) FROM FIELD NUMBER 4018 TO 4006.
C
C
      CALL PAGER(2)
      WRITE(6,100)
      CALL FRCL(4003,VOL,IS,IR)
```

```
      D=2.*VOL**(1./3.)
      CALL PAGER(3)
      WRITE(6,102)
      CALL FSV(4007,D,4)
      CALL MODE1
      CALL MODE2
      CALL FRCL(4018,H,IS,IR)
      CALL FSV(4006,H,6)
      CALL MODB2
      CALL PAGER(2)
      WRITE(6,101)
      RETURN
  100 FORMAT(85H MODEL Q IS REPLACED BY THE EXECUTION OF MODELS E1,E2, A
     1ND B2 - EXECUTION PROCEEDING./)
  101 FORMAT (18H MODEL Q EXECUTED./)
  102 FORMAT(67H MODEL Q ASSUMES THAT THE DIAMETER OF THE FLAME IS TWICE
     * THE VOLUME/ 56H OF THE LIQUID DISCHARGED TO THE 1/3 POWER, THEREF
     *ORE.../)
      END
      SUBROUTINE MODU
C
C     SUBROUTINE MODU CALLS THE THERMAL RADIATION  ESTIMATION ROUTINES
C     OF MODEL E FOR SPILLS OF LIGHTER-THAN-WATER, INSOLUBLE, FLAMMABLE
C     OR COMBUSTIBLE LIQUIDS.  IN DOING SO, IT TRANSFERS THE VALUE FOR
C     THE HEIGHT OF THE FLAME (COMPUTED IN MODE1) FROM FIELD NUMBER
C     4018 TO 4006.  THE POOL SIZE USED IS THAT COMPUTED IN MODT.
C
      CALL PAGER(2)
      WRITE(6,100)
      CALL MODE1
      CALL MODE2
      CALL FRCL(4018,H,IS,IR)
      CALL FSV(4006,H,6)
      CALL MODB2
      CALL PAGER(2)
      WRITE(6,101)
      RETURN
  100 FORMAT(77H MODEL U IS REPLACED BY EXECUTING MODELS E1,E2 AND B2 -
     1EXECUTION PROCEEDING./)
  101 FORMAT(18H MODEL U EXECUTED./)
      END
      SUBROUTINE PROTNK(D,AVP,BVP,CVP)
C
C  *********************************************************************
C     SUBROUTINE PROTNK EVALUATES THE RESPONSE OF THE WALL OF A CARGO
C     TANK CONTAINING A COMPRESSED LIQUEFIED GAS  ( NOT ONE WHICH HAS
C     BEEN LIQUEFIED BY REFRIGERATION) WHEN SUBJECTED TO HEATING BY
C     AN EXTERNAL FIRE.  OUTPUT INCLUDES THE TIME TO RUPTURE, MECHANICAL
C     STRESS IN THE WALL AT THE TIME OF RUPTURE, AND THE WALL
C     TEMPERATURE.  NOTE- THE ROUTINE REQUIRES DETAILED SPECIFICATION
C     OF THE PHYSICAL PROPERTIES OF THE WALL.  DEFAULT VALUES CONTAINED
C     IN HACS ARE TYPICAL OF THOSE FOR A PROPYLENE CARGO TANK.
C
C   *** INPUTS ***
C
C     D(1)     INTERNAL TANK DIAMETER                         CM
C     D(2)     WALL THICKNESS                                 CM
C     D(3)     FRACTION OF TANK VOLUME CONTAINING VAPOR       NON-DIM
C     D(4)     RELIEF VALVE SETTING (GAUGE PRESSURE)          DYNES/CM2
C     D(5)     HEAT FLUX AT OUTSIDE SURFACE OF TANK           CAL/CM2-SEC
C     D(6)     WALL THERMAL CONDUCTIVITY AT 0 DEG F          CAL/CM-S-DEG C
C     D(7)     WALL THERMAL CONDUCTIVITY AT 400 DEG F        CAL/CM-S-DEG C
C     D(8)     WALL THERMAL CONDUCTIVITY AT 800 DEG F        CAL/CM-S-DEG C
C     D(9)     WALL THERMAL CONDUCTIVITY AT 1200 DEG F       CAL/CM-S-DEG C
C     D(10)    WALL THERMAL CONDUCTIVITY AT 1600 DEG F       CAL/CM-S-DEG C
C     D(11)    SPECIFIC HEAT OF WALL AT 0 DEG F                 CAL/GM-DEG C
C     D(12)    SPECIFIC HEAT OF WALL AT 400 DEG F               CAL/GM-DEG C
C     D(13)    SPECIFIC HEAT OF WALL AT 800 DEG F               CAL/GM-DEG C
C     D(14)    SPECIFIC HEAT OF WALL AT 1200 DEG F              CAL/GM-DEG C
C     D(15)    SPECIFIC HEAT OF WALL AT 1600 DEG F              CAL/GM-DEG C
C     D(16)    ULTIMATE TENSILE STRENGTH OF WALL AT 0 DEG F     DYNES/CM2
C     D(17)    ULTIMATE TENSILE STRENGTH OF WALL AT 400 DEG F   DYNES/CM2
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C       D(18)     ULTIMATE TENSILE STRENGTH OF WALL AT 800 DEG F  DYNES/CM2
C       D(19)     ULTIMATE TENSILE STRENGTH OF WALL AT 1200 DEG F DYNES/CM2
C       D(20)     ULTIMATE TENSILE STRENGTH OF WALL AT 1600 DEG F-DYNES/CM2
C       AVP, BVP, AND CVP ARE CORRELATION CONSTANTS FOR THE VAPOR
C                 PRESSURE EQUATION WHICH GIVES AN ANSWER IN UNITS
C                 OF MM HG.
C
C     *** OUTPUTS ***
C
C       D(21)     FAILURE PARAMETER FLAG.  D(21)=1.0 MEANS FAILURE OCCURS
C                 AT OUTSIDE OF WALL, =2.0 MEANS ITS AT INSIDE OF WALL,
C                 =3.0 MEANS THAT FAILURE DOES NOT OCCUR-THE TANK WALL CAN
C                 WITHSTAND STRESSES AND IS IN A STEADY-STATE CONDITION.
C        D(22)    FAILURE STRESS AT OUTSIDE OF WALL              DYNES/CM2
C       D(23)     TEMPERATURE AT OUTSIDE OF WALL                 DEG C
C       D(24)     FAILURE STRESS AT INSIDE OF WALL               DYNES/CM2
C       D(25)     TEMPERATURE AT INSIDE OF WALL                  DEG C
C       D(26)     IF D(22)=1.0 OR 2.0, THIS GIVES THE ELAPSED TIME
C                 FROM START OF FIRE UNTIL FAILURE OCCURS        SECS
C    ***********************************************************************
C
        REAL L1,L2,L3,L4,L5,K12,K23,K1,K2,K3,MCV1,MCV2,L6
        DIMENSION X(25),D(26)
        DATA PI,SBC/3.1415927,.1713E-8/
        DATA DT/1.666667E-3/
        IO=5
        IOUT=1
        CALL CVERT(D,IOUT)
        DO 8 IXD=1,4
      8 X(IXD)=D(IXD)
        Q=D(5)
        DO 9 IXD=6,20
      9 X(IXD-1)=D(IXD)
        DO 10 IXD=21,26
        D(IXD)=0.
     10 X(IXD-1)=0.
C
C    CALCULATE SATURATION TEMPERATURE AT RELIEF VALVE SETTING
        PSAT=(X(4)+14.696)/14.696
        PMM=PSAT*760.
        TSAT=(BVP/(AVP-ALOG10(PMM)))-CVP
        TSAT=(1.8*TSAT)+492.
        TSAT4=TSAT**4
        T3=TSAT+30.
C
C    SOLVE FOR COEFFICIENTS OF A CURVE FIT OF THE PHYSICAL PROPERTIES
C       OF THE WALL
        A0=X( 7)
        A4=4.*(.5*(X( 5)+X( 9))-2.*(X( 6)+X( 8))+3.*A0)/3.
        A2=2.*(X( 6)+X( 8)-2.*A0-.125*A4)
        A3=4.*(X( 9)-2.*X( 8)+A0-.5*A2-.875*A4)/3.
        A1=X( 9)-A0-A2-A3-A4
        B0=X(12)
        B4=4.*(.5*(X(10)+X(14))-2.*(X(11)+X(13))+3.*B0)/3.
        B2=2.*(X(11)+X(13)-2.*B0-.125*B4)
        B3=4.*(X(14)-2.*X(13)+B0-.5*B2-.875*B4)/3.
        B1=X(14)-B0-B2-B3-B4
        Y0=X(17)
        Y4=4.*(.5*(X(15)+X(19))-2.*(X(16)+X(18))+3.*Y0)/3.
        Y2=2.*(X(16)+X(18)-2.*Y0-.125*Y4)
        Y3=4.*(X(19)-2.*X(18)+Y0-.5*Y2-.875*Y4)/3.
        Y1=X(19)-Y0-Y2-Y3-Y4
C    FIND ANGLE OF INTERSECTION OF MENISCUS
        PHI0=PI/2.
     20 PHI1=PHI0+(PI*X(3)-(PHI0-.5*SIN(2.*PHI0)))/(1.-COS(2.*PHI0))
        PABS=ABS(PHI1-PHI0)
        IF(PABS.LT.1.E-4) GO TO 30
        PHI0=PHI1
        GO TO 20
C    CALCULATE VIEW AREAS FOR TWO WALL NODES
     30 L1=X(1)*SIN(PHI1/4.)
        L2=L1
```

```
      L3=X(1)*SIN(PHI1)
      L4=.5*X(1)*SQRT(2.*(1.-COS(PHI1)))
      L5=.5*X(1)*SQRT((COS(PHI1/2.)-COS(PHI1))**2+(SIN(PHI1/2.)
     A +SIN(PHI1))**2)
      L6=L4
      F35=(L5+L3-L2)/(2.*L3)
      F23=L3*(1.-F35)/L2
      F45=(L5+L4-L1)/(2.*L4)
      F14=L4*(1.-F45)/L1
      F26=(L6+L2-L1)/(2.*L2)
      F12=L2*(1.-F26)/L1
      F13=1.-F12-F14
C
      SAF1=SBC*L1*F13
      SAF2=SBC*L2*F23
      AL=.5*X(1)*SIN(PHI1/2.)
C
C  STEADY STATE SOLUTION
      ISS=1
      T11=(Q*AL/SAF1+TSAT4)**.25
      T21=T11
      T1S=T11
      T2S=T11
      T10=T11
      T20=T11
   55 TN=(T11+T21-460.-2060.)/1600.
      K12=A0+A1*TN+A2*TN**2+A3*TN**3+A4*TN**4
      K12=K12*X(2)/(AL*12.)
      F1=Q*AL-K12*(T11-T21)-SAF1*(T11**4-TSAT4)
      DF1=-K12-4.*SAF1*T11**3
      T1N=T11-F1/DF1
      ABS1=ABS(T1N-T11)
      IF(ABS1.LT.0.001) GO TO 60
      T11=T1N
      GO TO 55
   60 TN=(T11+T21-460.-2060.)/1600.
      K12=A0+A1*TN+A2*TN**2+A3*TN**3+A4*TN**4
      K12=K12*X(2)/(AL*12.)
      TN =(T21+ T3-460.-2060.)/1600.
      K23=A0+A1*TN+A2*TN**2+A3*TN**3+A4*TN**4
      K23=K23*X(2)/(.5*AL*12.)
      F2=Q*AL-K12*(T21-T11)-K23*(T21-T3)-SAF2*(T21**4-TSAT4)
      DF2=-K12-K23-4.*SAF2*T21**3
      T2N=T21-F2/DF2
      ABS2=ABS(T2N-T21)
      IF(ABS2.LT.0.001) GO TO 70
      T21=T2N
      GO TO 60
   70 ABS1=ABS(T11-T1S)
      ABS2=ABS(T21-T2S)
      IF(ABS1.LT..001.AND.ABS2.LT.0.001) GO TO 180
      T1S=T11
      T2S=T21
      GO TO 55
C  INTEGRATE NODE TEMPERATURES AT 6 SEC INCREMENTS--TEMPERATURES ARE
C      IN DEGREES RANKINE
C  BEGIN THE ITERATION
   90 ISS=0
      TIME=0.
      T11=520.
      T21=520.
      T1S=520.
      T2S=520.
  100 TIME=TIME+0.1
      T10=T11
      T20=T21
C  CALCULATE THERMAL CONDUCTIVITIES AND SPECIFIC HEATS
  120 TN =(T11+T21-460.-2060.)/1600.
      K12=A0+A1*TN+A2*TN**2+A3*TN**3+A4*TN**4
      K12=K12*X(2)/(AL*12.)
      TN =(2.*T11-460.-2060.)/1600.
      MCV1=B0+B1*TN+B2*TN**2+B3*TN**3+B4*TN**4
```

```
      MCV1=MCV1*.29*X(2)*AL*144.
      F1=T11-T10-(Q*AL-K12*(T11-T21)-SAF1*(T11**4-TSAT4))*DT/MCV1
      DF1=1.+(K12+4.*SAF1*T11**3)*DT /MCV1
      T1N=T11-F1/DF1
      ABS1=ABS(T1N-T11)
      IF(ABS1.LT.0.001) GO TO 140
      T11=T1N
      GO TO 120
  140 TN =(T11+T21-460.-2060.)/1600.
      K12=A0+A1*TN+A2*TN**2+A3*TN**3+A4*TN**4
      K12=K12*X(2)/(AL*12.)
      TN =(T21+ T3-460.-2060.)/1600.
      K23=A0+A1*TN+A2*TN**2+A3*TN**3+A4*TN**4
      K23=K23*X(2)/(.5*AL*12.)
      TN =(2.*T21-460.-2060.)/1600.
      MCV2=B0+B1*TN+B2*TN**2+B3*TN**3+B4*TN**4
      MCV2=MCV2*.29*X(2)*AL*144.
      F2=T21-T20-(Q*AL-K12*(T21-T11)-K23*(T21-T3)-SAF2*(T21**4-TSAT4))
     A *DT/MCV2
      DF2=1.+(K12+K23-4.*SAF2*T21**3)*DT /MCV2
      T2N=T21-F2/DF2
      ABS2=ABS(T2N-T21)
      IF(ABS2.LT.0.001) GO TO 160
      T21=T2N
      GO TO 140
  160 ABS1=ABS(T11-T1S)
      ABS2=ABS(T21-T2S)
      IF(ABS1.LT..001.AND.ABS2.LT..001) GO TO 180
      T1S=T11
      T2S=T21
      GO TO 120
C  CALCULATE STRESSES AND COMPARE WITH TENSILE STRENGTH
C  ...NOTE THAT THE TEMPERATURES WE'VE SOLVED FOR ARE THOSE OF THE INSID
C     SURFACE OF THE WALL
C  ASSUME THAT MAXIMUM TEMPERATURES ARE AT TOP OF TANK
  180 TN =(2.*T11-460.-2060.)/1600.
      K1 =A0+A1*TN+A2*TN**2+A3*TN**3+A4*TN**4
      SUI=Y0+Y1*TN+Y2*TN**2+Y3*TN**3+Y4*TN**4
      T1M=Q*X(2)/(K1*AL*12.)+T11
      TN =(2.*T1M-460.-2060.)/1600.
      SUO=Y0+Y1*TN+Y2*TN**2+Y3*TN**3+Y4*TN**4
C  STRESSES AT INSIDE AND OUTSIDE
      DO2=(X(1)+2.*X(2)/12.)**2
      DI2=X(1)*X(1)
      SC=X(4)*DI2/(DO2-DI2)
      SRI=SC*(1.-DO2/DI2)
      STI=SC*(1.+DO2/DI2)
      SZI=SC
      SRO=0.0
      STO=2.*SC
      SZO=SC
      FCO=.707107*SQRT((SRO-STO)**2+(STO-SZO)**2+(SZO-SRO)**2)
      FCI=.707107*SQRT((SRI-STI)**2+(STI-SZI)**2+(SZI-SRI)**2)
      IF(SUO.LE.FCO.OR.SUI.LE.FCI) GO TO 280
      IF(ISS.EQ.0) GO TO 100
      X(20)=3.
      X(25)=0.
      GO TO 301
  280 IF(ISS.EQ.1) GO TO 90
      IF(SUO.GT.FCO) GO TO 300
      X(20)=2.
      GO TO 301
  300 X(20)=1.
  301 X(21)=FCO
      X(22)=T1M-460.
      X(23)=FCI
      X(24)=T11-460.
      X(25)=TIME
      DO 310 IXD=21,26
  310 D(IXD)=X(IXD-1)
      IOUT=2
      CALL CVERT(D,IOUT)
```

```
      D(21)=D(21)+0.0001
      RETURN
      END
      SUBROUTINE SVEIW(THETA,HF,S,DT,VF)
C
C     THIS SUBROUTINE IS USED BY THE RADIATION FLUX SUBROUTINE.
C     NO SPECIAL INPUTS ARE REQUIRED FOR THIS ROUTINE BEYOND THOSE
C     LISTED IN SUBROUTINE JHHRF
C
      RT=DT/2.
      X=S-RT
      HT=0.0
      HO=0.0
      XK=X
      XM=0.0
      PM=0.0
      IF(THETA.LE.0.0) GO TO 41
      PF = HT/SIN(THETA) + HF*COS(THETA)/SIN(THETA)
      XM = PM*COS(THETA)
      XF = XM + HF/SIN(THETA)
   41 RT=DT/2.
      EX = X+RT
      IF(THETA) 42,42,43
   43 XC = PM + (X-XM)*COS(THETA)
      EXC = XC + RT
      D = EXC/RT
      HFA = (X-XM)*SIN(THETA)
      HFB = (XF-X)*SIN(THETA)
      GO TO 44
   42 EXC = EX
      D = EXC/RT
      HF1=HT
      HF2 = HF + HT
      GO TO 95
   44 IF (X-XM) 105,205,305
  105 HF1 = -HFA
      HF2 = HFB
      GO TO 95
  205 HF2 = HF
      HF1 = 0.0
      GO TO 95
  305 IF (X-XF) 405,605,705
  405 HF1 = HFA
      HF2 = HFB
      GO TO 95
  605 HF2 = HF
      HF1 = 0.0
      GO TO 95
  705 HF1 = HFA
      HF2 = -HFB
      GO TO 95
   95 ELV1 = HF1/RT
      ELV2 = HF2/RT
      A1 = (D+1.)**2 +ELV1**2
      A2 = (D+1.)**2 +ELV2**2
      B1 = (D-1.)**2 + ELV1**2
      B2 = (D-1.)**2 + ELV2**2
      ARGA1 = ELV1/((D**2-1.)**.5)
      ARGA2 = ELV2/((D**2-1.)**.5)
      ARGB1 = ((A1*(D-1.))/(B1*(D+1.)))**.5
      ARGB2 = ((A2*(D-1.))/(B2*(D+1.)))**.5
      ARGC = ((D-1.)/(D+1.))**.5
      F1 = (1./(3.1416*D))*ATAN(ARGA1) + (ELV1/3.1416)*(((A1-(2.*D))/
     1(D*((A1*B1)**.5)))*ATAN(ARGB1) - (1./D)*ATAN(ARGC))
      F2 = (1./(3.1416*D))*ATAN(ARGA2) + (ELV2/3.1416)*(((A2-(2.*D))/
     1(D*((A2*B2)**.5)))*ATAN(ARGB2) - (1./D)*ATAN(ARGC))
      IF (HO) 580,580,582
  580 IF(THETA) 118,118,45
  582 IF (THETA) 117,117,581
  581 IF (XK - XF) 117,116,119
   45 IF (X-XM) 118,116,90
   90 IF (X-XF) 117,116,119
```

```
  116 VF = F2
      GO TO 96
  117 VF = F2 + F1
      GO TO 96
  118 VF = F2-F1
      GO TO 96
  119 VF = F1 - F2
   96 RETURN
      END
      OVERLAY(5,0)
      PROGRAM OV5
C
C        OV5 EXECUTES THE FOLLOWING INTER-RELATED GROUP OF VAPOR
C        DISPERSION RATE MODELS -
C
C                  RATE MODEL  =  C    INDEX  =  3
C                                 G              7
C                                 J             10
C                                 N             14
C                                 S             19
C                                 W             23
C
C        COMMON VARIABLES USED - MODNO
C
C        SUBROUTINES REQUIRED  - MODC1,MODC2,MODG,MODJ,MODN,MODS,MODW,
C                                TRACE
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 8 JANUARY 1976
C
C
      COMMON/OVCNT/MODNO,OVLST(29),SGLST(29)
      INTEGER      OVLST,SGLST
C
C
C--------PRINT OVERLAY EXECUTION TRACE MESSAGE, THEN BRANCH ON MODEL
C        INDEX NUMBER
      CALL TRACE(0,5,0)
C
C--------SELECT MODEL C
      IF(MODNO.NE.3) GO TO 10
      CALL MODC1
      CALL MODC2
      GO TO 100
C
C--------SELECT MODEL G
   10 IF(MODNO.NE.7) GO TO 20
      CALL MODG
      GO TO 100
C
C--------SELECT MODEL J
   20 IF(MODNO.NE.10) GO TO 30
      CALL MODJ
      GO TO 100
C
C--------SELECT MODEL N
   30 IF(MODNO.NE.14) GO TO 40
      CALL MODN
      GO TO 100
C
C--------SELECT MODEL S
   40 IF(MODNO.NE.19) GO TO 50
      CALL MODS
      GO TO 100
C
C--------SELECT MODEL W
   50 IF(MODNO.NE.23) GO TO 100
      CALL MODW
C
```

```
C---------PRINT OVERLAY EXECUTION TRACE MESSAGE, THEN RETURN TO MAIN
C         HACS CONTROL
  100 CALL TRACE(1,5,0)
C
      END
      SUBROUTINE CONVAP(X,Y,Z,T,H,MDOT,UWIND,IATM,IDIM,SIZE,CHNLW,C)
C
C***********************************************************************
C
C    THE NAME OF THIS PROGRAM IS CONVAP.  IT RETURNS THE VALUE OF
C    CONCENTRATION (GM/CM**3) AT POINT X,Y,Z, AT TIME T FOR VAPOR
C    RELEASE FROM A CONTINUOUS SOURCE.  BOTH CIRCULAR AND ONE-DIMENSIONAL
C    SOURCES ARE CONSIDERED.
C
C    INPUT ARGUMENTS
C
C    X      = WIND DIRECTION CO-ORDINATE                          CMS
C    Y      = CROSS WIND CO-ORDINATE                              CMS
C    Z      = HEIGHT CO-ORDINATE                                  CMS
C    T      = TIME AFTER THE SPILL/LEAK AT WHICH THE
C             CONCENTRATION IS DESIRED.                           SECS
C    H      = HEIGHT OF THE CENTER LINE OF THE SOURCE ABOVE
C               GROUND                                            CMS
C    MDOT   = AVERAGE RATE OF GAS OR VAPOR DISCHARGE              GM/SEC
C    UWIND  = WIND VELOCITY                                       CMS/SEC
C    IATM   = ATMOSPHERIC CONDITION AS DEFINED IN
C               SUBROUTINE JHHDC
C    IDIM   = DIMENSION OF SPILL (1 IF ONE DIMENSIONAL,
C               2 IF RADIAL)
C    SIZE   = MAXIMUM RADIUS/LENGTH OF POOL.                      CMS
C    CHNLW  = CHANNEL WIDTH (REQUIRED FOR IDIM=1 ONLY)            CMS
C
C    OUTPUT ARGUMENTS
C
C    C      = VAPOR CONCENTRATION                                 GMS/CM**3
C
C***********************************************************************
C
      REAL MDOT
      PI=3.141592654
C
C    CHECKING TO SEE IF THE CLOUD HAS REACHED POINT XYZ OR WHETHER
C    THE TRAILING EDGE OF THE CLOUD HAS PASSED THE POINT.
C    TRVLT IS THE TRAVEL TIME FOR WIND BETWEEN THE SOURCE AND POINT XYZ.
C
      TRVLT=X/UWIND
      IF(T-TRVLT) 10,20,20
   10 C=0.0
      RETURN
   20 VIRDIS=10.*SIZE
      IF(IDIM-1) 40,40,50
   40 A=CHNLW*SIZE
      VIRDIS=10.*SQRT(A/PI)
   50 XC=X+VIRDIS
      CALL JHHDC(XC,IATM,SIGY,SIGZ)
      C0=MDOT/(2.*PI*SIGY*SIGZ*UWIND)
      D1=EXP(-1.*((Z-H)*(Z-H)/(2.*SIGZ*SIGZ)))
      D2=EXP(-1.*((Z+H)*(Z+H)/(2.*SIGZ*SIGZ)))
      C3=EXP(-1.*Y*Y/(2.*SIGY*SIGY))
      C=C0*C3*(D1+D2)
      RETURN
      END
      SUBROUTINE ITOX(CHAZ,AM,IFLAG,C)
C
C     THIS ROUTINE CONVERTS VAPOR CONCENTRATIONS EXPRESSED IN UNITS
C     OF MOLE PERCENT OR PPM TO UNITS OF GM/CM**3.
C
C****INPUTS
C     CHAZ   THE CONCENTRATION OF THE CHEMICAL VAPOR OR GAS IN AIR
C            (MOLE PERCENT IF IFLAG IS 0, PPM IF IFLAG IS 1)
C     AM     MOLECULAR WEIGHT OF THE CHEMICAL
C     IFLAG  FLAG INDICATING WHETHER MOLE PERCENT OR PPM CONCENTRATION
```

```
C            IS BEING GIVEN AS INPUT
C
C****OUTPUTS
C
C     C      THE CORRESPONDING CONCENTRATION IN GM/CM**3.
C
      IF(IFLAG-0) 20,20,10
   10 CHAZ=CHAZ/1000000.0
      GO TO 25
   20 CHAZ=CHAZ/100.0
   25 DENV=AM/22414.
      DENA= 0.0012894
      C=1./((1./DENV)+(((1.-CHAZ)*28.9)/(CHAZ*AM*DENA)))
      IF(IFLAG.EQ.0) CHAZ=CHAZ*100.0
      IF(IFLAG.EQ.1) CHAZ=CHAZ*1000000.0
      RETURN
      END
      SUBROUTINE IVAPC(TMG,UWIND,H,C,X,Y,IAC,IDIM,SW,SIZE,CHNLW,TIME,DUR
     1N,JFLAG)
C
C**********************************************************************
C     THIS ROUTINE IS THE INVERSION OF ROUTINE VAPC.  IT GIVES THE WIDTH
C     OF A GIVEN CONCENTRATION LEVEL IN A VAPOR CLOUD AT ANY POSITION X
C     DOWNWIND AT THE GROUNDLEVEL.  IT ALSO RETURNS THE TIME OF ARRIVAL
C     OF THE CLOUD AT DOWNWIND CENTERLINE POSITION X AND THE DURATION
C     FOR WHICH THE VAPOR CONCENTRATION REMAINS ABOVE A HAZARDOUS LEVEL
C     AT A SPECIFIED POSITION X,Y.
C
C ***** INPUT ARGUEMENTS
C
C      TMG       TOTAL WEIGHT OF VAPOR DISCHARGED           GRAMS
C      UWIND     MEAN WIND VELOCITY IN SPILL AREA           CM/SEC
C     H          HEIGHT OF THE CENTERLINE OF THE DISCHARGE
C                HOLE ABOVE GROUNDLEVEL                     CMS
C     C          HAZARDOUS CONCENTRATION WHOSE CONTOUR WIDTH
C                IN THE CLOUD IS DESIRED                    GM/CM**3
C     X          DOWNWIND CENTERLINE DISTANCE AT WHICH THE
C                SPECIFIC CONTOUR WIDTH IS DESIRED          CM
C     Y          ANY CROSSWIND POSITION
C                (MEASURED FORM CENTERLINE DOWNWIND DIRECTION)  CM
C     IAC        ATMOSPHERIC CONDITION FLAG
C                ( 1 TO 6 FOR CONDITIONS A TO F RESPECTIVELY)
C     SIZE       THE LENGTH OR RADIUS OF THE VAPOR SOURCE
C                DEPENDING ON IDIM DEFINITION               CM
C     CHNLW      WIDTH OF VAPOR SOURCE ( FOR IDIM=1 ONLY)   CM
C
C *** OUTPUT ARGUEMENTS
C
C     SW         HALF WIDTH OF THE ZONE IN THE CLOUD THAT
C                IS AT OR ABOVE CONCENTRATION C AT X        CM
C     TIME       ELAPSED TIME WHEN CLOUD REACHES DOWNWIND
C                DISTANCE GIVEN BY X                        SEC
C     DURN       TIME SPAN DURING WHICH CONCENTRATION AT
C                POINT X,Y WILL EXCEED C                    SEC
C     JFLAG      FLAG INDICATING WHETHER POINT X,Y IS INSIDE
C                OR OUTSIDE THE HAZARD ZONE. (1=INSIDE, 2=OUTSIDE)
C
C**********************************************************************
      PI=3.14159256
      IF(IDIM-1) 30,30,40
   30 A=SIZE*CHNLW
      SIZE=SQRT(A/PI)
   40 FACT=10.*SIZE
      X=X+FACT
      CALL JHHDC(X,IAC,SIGY,SIGZ)
      SIGX=SIGY
      C1=(TMG/((2.*PI)**1.5*SIGX*SIGY*SIGZ))
      A1=EXP(-H**2/(2.*SIGZ**2))
      A2=EXP(-H**2/(2.*SIGZ**2))
      C3=C1*A2
      C2=C1*A1
      CO=C2+C3
```

```
      X=X-FACT
      SW=0.
      IF(C.GE.CO) GO TO 5
      SW=SIGY*SQRT(2.*ALOG(CO/C))
    5 CONTINUE
      IF(SW.LE.0.0) TIME=0.0
      IF(SW.GT.0.0) TIME=(X-SW)/UWIND
      IF(Y-SW)10,20,20
10    DURN=2.*SQRT(SW**2-Y**2)/UWIND
      IF (IDIM-1) 70,70,80
   70 SIZE=A/CHNLW
   80 JFLAG=1
      RETURN
   20 JFLAG=-1
      DURN=0.
      IF(IDIM-1) 50,50,60
   50 SIZE=A/CHNLW
   60 RETURN
      END
      SUBROUTINE IVAPCN(X,Y,Z,H,SORDRN,MDOT,SIZE,IDIM,CHNLW,UWIND,IATM,
     *C,SW,TIME,DURN)
C
C***********************************************************************
C
C      IVAPCN STANDS FOR INVERSION OF CONTINUOUS VAPOR DISPERSION
C    MODEL.  IT RETURNS A VALUE FOR THE MAXIMUM WIDTH TO A
C    CONCENTRATION CONTOUR AT ANY DOWNWIND DISTANCE X AND VERTICAL
C    LOCATION Z.  THE SOURCE IS A CONTINUOUS SOURCE.  THE ROUTINE
C    ALSO RETURNS A VALUE FOR THE FLAG JFLAG DEPENDING ON WHETHER THE
C    POINT Y IS WITHIN THE CLOUD OR NOT.
C
C    INPUT ARGUMENTS
C
C    X      = DOWN WIND POSITION AT WHICH THE MAXIMUM
C             WIDTH OF HAZARD ZONE IS TO BE KNOWN.         CMS
C    Y      = ANY CROSS WIND POSITION.                     CMS
C    Z      = HEIGHT CO-ORDINATE.                          CMS
C    H      = HEIGHT OF THE CENTER LINE OF THE HOLE ABOVE
C             GROUND.                                      CMS
C    SORDRN= DURATION FOR WHICH THE SOURCE IS ACTIVE.      SECS
C    MDOT   = AVERAGE RATE OF GAS OR VAPOR DISCHARGE       GM/SEC
C    SIZE   = MAXIMUM RADIUS/LENGTH OF POOL.               CMS
C    IDIM   = DIMENSION OF SPILL (1 IF ONE DIMENSIONAL,
C             2 IF RADIAL)
C    CHNLW  = CHANNEL WIDTH (REQUIRED FOR IDIM=1 ONLY)     CMS
C    UWIND  = WIND VELOCITY                                CMS/SEC
C    IATM   = ATMOSPHERIC CONDITION.
C    C      = HAZARDOUS CONCENTRATION-WHOSE CONTOUR WIDTH
C             IS TO BE KNOWN.                              GMS/CM**3
C
C    OUTPUT ARGUMENTS
C
C    SW     = HALF WIDTH OF THE HAZARDOUS ZONE.            CMS
C    TIME   = TIME OF ARRIVAL AT X OF THE HAZARDOUS CONC.  SECS
C    DURN   = DURATION FOR WHICH HAZARDOUS CLOUD AT XYZ    SECS
C
C***********************************************************************
C
      REAL MDOT
      PI=3.141592654
      A=PI*SIZE*SIZE
      VIRDIS=10.*SIZE
      IF(IDIM-1) 10,10,20
   10 A=CHNLW*SIZE
      VIRDIS=10.*SQRT(A/PI)
   20 XC=X+VIRDIS
      CALL JHHDC(XC,IATM,SIGY,SIGZ)
      CO=MDOT/(2.*PI*SIGY*SIGZ*UWIND)
      D1=EXP(-1.*((Z-H)*(Z-H)/(2.*SIGZ*SIGZ)))
      D2=EXP(-1.*((Z+H)*(Z+H)/(2.*SIGZ*SIGZ)))
      F=C/(CO*(D1+D2))
      SW=0.
```

```
      CMAX=CO*(D1+D2)
      IF(C-CMAX) 30,40,40
   30 SW=SQRT(-2.*SIGY*SIGY*ALOG(F))
   40 IF(SW.LE.0.0) TIME=0.0
      IF(SW.GT.0.0) TIME=X/UWIND
      DURN=SORDRN+TIME
      IF(TIME.EQ.0.0) DURN=0.0
      RETURN
      END
      SUBROUTINE JHHDC(XXL,IAC,SIGY,SIGZ)
C     XL IS THE X COORDINATE OF POINT WHERE CONCENTRATION IS TO BE
C        CALCULATED (INPUT IN CM)
C     IAC  INDICATES WEATHER CONDITIONS AT TIME OF SPILL (INPUT)
C        IAC=1   FOR EXTREMELY UNSTABLE CONDITIONS (A)
C        IAC=2   FOR MODERATELY UNSTABLE CONDITIONS (B)
C        IAC=3   FOR SLIGHTLY UNSTABLE CONDITIONS (C)
C        IAC=4   FOR NEUTRAL CONDITIONS (D)
C        IAC=5   FOR SLIGHTLY STABLE CONDITIONS (E)
C        IAC=6   FOR MODERATELY STABLE CONDITIONS (F)
C     SIGY AND SIGZ ARE DISPERSION COEFFICIENTS (OUTPUTS)
C
C     THE FORMS OF THE EQUATIONS USED IN THIS ROUTINE AND THE
C     COEFFICIENTS UTILIZED IN THEM WERE DETERMINED BY LEAST
C     SQUARE FITTING PROGRAMS TO BEST REPRESENT THE DISPERSION
C     COEFFICIENT CURVES GIVEN BY GIFFORD AND PASQUILL.
C     THE SIMPLIFIED EQUATIONS USUALLY FOUND IN THE LITERATURE
C     WERE FOUND TO BE CONSIDERABLY IN ERROR UNDER MANY CIRCUMSTANCES.
C
      DIMENSION AO(6),AONE(6),ATWO(6),S(5,5),ER(6)
      DATA
     * S(1,1) /    .90 /, S(2,1) /    .913/, S(3,1) /    .919/,
     * S(4,1) /    .919/, S(5,1) /    .919/,
     * S(1,2) /158.    /, S(2,2) /104.    /, S(3,2) / 69.    /,
     * S(4,2) / 51.    /, S(5,2) / 34.    /,
     * S(1,3) /  2.041/, S(2,3) /  1.786/, S(3,3) /  1.505/,
     * S(4,3) /  1.332/, S(5,3) /  1.146/,
     * S(1,4) /  1.048/, S(2,4) /    .916/, S(3,4) /    .737/,
     * S(4,4) /    .678/, S(5,4) /    .650/,
     * S(1,5) /    .041/, S(2,5) /    .000/, S(3,5) /  -.105/,
     * S(4,5) /  -.112/, S(5,5) /  -.113/
      DATA AO(1) /-1.1840665/,AO(2)/-1.194544/, AO(3)/-1.1446466/,
     *     AO(4) /-1.4521136/,AO(5)/-1.793439/, AO(6)/-2.0571470/
      DATA AONE(1)/ .59323084/,AONE(2)/1.0679426/,AONE(3)/1.0130453/,
     *     AONE(4)/1.2195024 /,AONE(5)/1.3995561/,AONE(6)/1.47180410/
      DATA
     * ATWO(1)/ .23058351/,ATWO(2)/ .0033788564/,ATWO(3)/-.012671455/,
     * ATWO(4)/-.0800502 /,ATWO(5)/-.11727572  /,ATWO(6)/-.13377112 /
      DATA ER(1)/.098 /,ER(2)/.1726/,ER(3)/.1116/,
     *     ER(4)/.1314/,ER(5)/.1187/,ER(6)/.1186/
      XL=XXL
      XL=XL/100.
      IF(XL.LT.1.0) XL=1.0
      IF(IAC-1) 70,70,20
   20 IF(IAC-4) 21,10,10
   21 IF(XL-1000.) 30,30,10
   30 IAC=IAC-1
      SIGY=S(IAC,2)*((XL/1000.)**S(IAC,1))
      SIGZ=S(IAC,3)+(S(IAC,4)*((ALOG(XL/1000.))/2.303))+(S(IAC,5)*(((ALO
     1G(XL/100.))/2.303)**2))
      IAC=IAC+1
      IF(XL-10000.) 60,60,31
   31 SIGY=SIGY-(((ALOG(XL)/2.303)-4.)*ER(IAC)*SIGY)
      GO TO 60
   10 IAC=IAC-1
      SIGY=S(IAC,2)*((XL/1000.)**S(IAC,1))
      IAC=IAC+1
      IF(XL-10000.)80,80,83
   83 SIGY=SIGY-(((ALOG(XL)/2.303)-4.)*ER(IAC)*SIGY)
   80 SIGZ=AO(IAC)+(AONE(IAC)*(ALOG(XL)/2.303))+(ATWO(IAC)*((ALOG(XL)/
     12.303)**2.))
      GO TO 60
   70 SIGY=-.22758999+.84761524*(ALOG(XL)/2.303)
```

```
      SIGY=EXP(2.303*SIGY)
      IF(XL-2000.)71,71,72
   72 SIGY=SIGY+((((ALOG(XL)/2.303)-3.30103)/1.65321251)*ER(1)*SIGY)
   71 CONTINUE
      IF(XL-1000.) 81,81,80
   81 SIGZ=3.338834+(-2.8047118*(ALOG(XL)/2.303))+(.86706924*((ALOG(XL)/
     12.303)**2.))
      IF(XL-100.0) 82,82,60
   82 SIGZ=-1.0055+(0.46852*ALOG(XL))
   60 CONTINUE
      SIGZ=EXP(2.303*SIGZ)
      SIGY=SIGY*100.
      SIGZ=SIGZ*100.
      XL=100.*XL
      RETURN
      END
      SUBROUTINE MODC1
C
C     SUBROUTINE MODC1 IS A PART OF THE GENERALIZED VAPOR DISPERSION
C     MODEL C.  IT FINDS THE MAXIMUM EXTENTS OF FIRE AND TOXICITY
C     HAZARDS OF A CLOUD OR PLUME USING ROUTINES VAPC AND CONVAP FOR
C     INSTANTANEOUS AND CONTINUOUS RELEASES RESPECTIVELY.  FOR AN
C     INSTANTANEOUS RELEASE, IT ALSO GIVES THE CONCENTRATION VS TIME
C     AT A USER SPECIFIED POINT.
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      DIMENSION AC(20,2),AX(20),AT(20),ASAVC(20),ASAV(20)
     0DIMENSION PTITL(6),PTIT(6),XTITL1(6),XTITL2(6),XTITL3(6),
     1          XTITL4(6),YTITL1(6),YTITL2(6)
      EQUIVALENCE (XBX(1),AT(1)),(XBX(81),AX(1)),(XBX(21),AC(1,1))
      EQUIVALENCE (XBX(64),IC1PF),(XBX(61),X),(XBX(62),Y)
      EQUIVALENCE (XBX(63),Z),(XBX(65),AM)
      EQUIVALENCE (XBX(101),ASAVC(1)),(XBX(121),ASAV(1))
      DATA MOD/1H C1 /
     0DATA (PTITL (I),I=1,6)/8HCONCENTR,8HATION VS,8H TIME AT,
     18H A FIXED,'H POINT -,8H MODEL C/
     0DATA (PTIT  (I),I=1,6)/8HMAX GROU,8HND CONC ,8HVS TIME/,
     18HDISTANCE,8H - MODEL,8H C      /
     0DATA (XTITL1(I),I=1,6)/8HELAPSED ,8HTIME....,8H........,
     18H........,8H.......(,8HMINUTES)/
     0DATA (XTITL2(I),I=1,6)/8HELAPSED ,8HTIME....,8H........,
     18H........,8H........,8H.(HOURS)/
     0DATA (XTITL3(I),I=1,6)/8HDOWNWIND,8H DISTANC,8HE.......,
     18H........,8H........,8H(METERS)/
     0DATA (XTITL4(I),I=1,6)/8HELAPSED ,8HTIME....,8H........,
     18H........,8H.......(,8HMINUTES)/
     0DATA (YTITL1(I),I=1,6)/8HCONCENTR,8HATION   ,8HAT POINT,
     18H XYZ    ,8H(MOLE PE,8HRCENT)  /
     0DATA (YTITL2(I),I=1,6)/8HMAXIMUM ,1H ,8HCONCENTR,
     18HATION   ,8H(MOLE PE,8HRCENT)  /
    1 CONTINUE
      IR=0
      LP=6
      ZR=0.
      IS=6
      TR=0.
C
C         ACCESS DATA ITEMS
C
      CALL BEGPR(MOD)
      CALL IRCL(2061,INC,IS,IR)
      CALL FRCL(1002,AM,IS,IR)
      CALL FRCL(2012,X,IS,IR)
      CALL FRCL(2013,Y,IS,IR)
      CALL FRCL(2014,Z,IS,IR)
      CALL FRCL(2015,H,IS,IR)
      CALL FRCL(2016,UWIND,IS,IR)
      CALL IRCL(2017,IAC,IS,IR)
      CALL IRCL(2018,IDIM,IS,IR)
      CALL FRCL(2019,SIZE,IS,IR)
      IF(IDIM.EQ.1) CALL FRCL(2020,CHNLW,IS,IR)
```

```
      CALL FRCL(2032,CTOX,IS,IR)
      CALL FRCL(2033,CFIR,IS,IR)
      CALL FRCL(2054,AIRTM,IS,IR)
      IF(INC.EQ.0) CALL FRCL(4001,TMG,IS,IR)
      IF(INC.EQ.1) CALL FRCL(4044,FLOW,IS,IR)
      IF(INC.EQ.1) CALL FRCL(4045,SORDRN,IS,IR)
      CALL FRCL(4068,AVTEM,IS,IR)
      CALL IRCL(3004,IC1PF,IS,IR)
      CALL IRCL(3005,IC2PF,IS,IR)
      IW=0
      IF(INC.EQ.0) GO TO 93
      IF(IC1PF.EQ.1.OR.IC1PF.EQ.3) IW=1
      IF(IC2PF.LE.1.AND.IW.EQ.1) IW=2
      IF(IC2PF.EQ.0.AND.IW.EQ.2) IC2PF=2
      IF(IC2PF.EQ.1.AND.IW.EQ.2) IC2PF=3
      IF(IW.EQ.0.OR.IW.EQ.2) GO TO 93
      IF(IC2PF.GE.2) IW=3
   93 CONTINUE
      IF(IC1PF - 2) 4,2,2
    2 CALL FRCL(2035,XMX,IS,IR)
    4 CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
      CALL OUTPR(MOD)
C
C     FIND RELATIVE DENSITY OF GAS OR VAPOR WITH AIR AT DISCHARGE
C
      DAIR=(0.079987+(-0.000237*AIRTM))*0.01603
      CALL COMPG(AM,AVTEM,DGAS)
      RATIO=DGAS/DAIR
C
C     ITERATE TO FIND MAX EXTENTS OF FIRE AND TOXICITY HAZARDS
C
      IF(CFIR.NE.0.0) CALL ITOX(CFIR,AM,0,CFIRE)
      IF(CTOX.NE.0.0) CALL ITOX(CTOX,AM,1,CTOXX)
      IXX=1
      IF(CFIR.EQ.0.0) XMN=0.0
      IF(CFIR.EQ.0.0) GO TO 65
      CHAZ=CFIRE
      ISTP=0
   81 IF(INC .EQ. 0 .AND.TMG.GT. 0.)GO TO 8882
      IF(INC.NE.0)GO TO 8883
      DX=-32816./6.
      GO TO 8883
 8882 IF(INC.EQ.0) DX=((6355.*ALOG10(TMG))-32816.)/6.
 8883 IF(INC.EQ.1) DX=305.0
      IF(DX.LT.305.0) DX=305.0
      IF(H.LE.1.0) GO TO 80
      IF(IDIM.EQ.2) ADDJ=10.*SIZE
      IF(IDIM.EQ.1) ADDJ=10.*SQRT(CHNLW*SIZE/3.14159)
      XONE=305.+ADDJ
      XTWO=XONE
      XJH=XONE
      CALL JHHDC(XONE,IAC,SIGY,SIGZ)
      SSS=H*H/(2.*SIGZ*SIGZ)
      AAAA=100000000.0
      IF(SSS.GT.87.) CNC1=0.0
      IF(SSS.GT.87.) GO TO 51
      IF(INC.EQ.0) CNC1=AAAA/(SIGY*SIGY*SIGZ*EXP(H*H/(2.*SIGZ*SIGZ)))
      IF(INC.EQ.1) CNC1=AAAA/(SIGY*SIGZ*EXP(H*H/(2.*SIGZ*SIGZ)))
   51 XTWO=((XTWO-ADDJ)*2.0)+ADDJ
      CALL JHHDC(XTWO,IAC,SIGY,SIGZ)
      SSS=H*H/(2.*SIGZ*SIGZ)
      IF(SSS.GT.87.) CNC2=0.0
      IF(SSS.GT.87.) GO TO 57
      IF(INC.EQ.0) CNC2=AAAA/(SIGY*SIGY*SIGZ*EXP(H*H/(2.*SIGZ*SIGZ)))
      IF(INC.EQ.1) CNC2=AAAA/(SIGY*SIGZ*EXP(H*H/(2.*SIGZ*SIGZ)))
   57 CONTINUE
      IF(CNC2.LT.CNC1) GO TO 52
      CNC1=CNC2
      XONE=XTWO
      GO TO 51
```

```
   52 XJHH=ABS(XJH-XONE)
      IF(XJHH.LT.0.1) GO TO 47
      A=150.
      IM=0
   54 XTHRE=XONE+A
      CALL JHHDC(XTHRE,IAC,SIGY,SIGZ)
      SSS=H*H/(2.*SIGZ*SIGZ)
      IF(SSS.GT.87.) CNC3=0.0
      IF(SSS.GT.87.) GO TO 58
      IF(INC.EQ.0) CNC3=AAAA/(SIGY*SIGY*SIGZ*EXP(H*H/(2.*SIGZ*SIGZ)))
      IF(INC.EQ.1) CNC3=AAAA/(SIGY*SIGZ*EXP(H*H/(2.*SIGZ*SIGZ)))
   58 CONTINUE
      IF(IM.EQ.1) GO TO 53
      IF(CNC3.LT.CNC1.AND.A.EQ.150.) A=-300.00
      IF(CNC3.GE.CNC1.AND.A.EQ.150.) A=300.00
      IF(CNC3.LT.CNC1.AND.A.EQ.100.) A=-100.0
      IF(CNC3.GE.CNC1.AND.A.EQ.100.) A=100.0
      IM=1
      GO TO 54
   53 IF(CNC3.LT.CNC1) GO TO 721
      CNC1=CNC3
      XONE=XTHRE
      IM=1
      GO TO 54
  721 B=ABS(A)
      IF(B.EQ.100.) GO TO 56
      IM=0
      A=100.0
      GO TO 54
   56 IF(IDIM.EQ.2) XMN=XONE-(10.*SIZE)
      IF(IDIM.EQ.1) XMN=XONE-(10.*SQRT(CHNLW*SIZE/3.14159))
   47 IF(INC.EQ.0) CCCC=(CNC1/AAAA)*(2.*TMG/((2.*3.14159265)**1.5))
      IF(INC.EQ.1) CCCC=(CNC1/AAAA)*(FLOW/(3.14159265*UWIND))
      IF(XJHH.LT.0.1) GO TO 80
      GO TO 50
   80 XMN=DX
   50 TYME=XMN/UWIND
      IF(INC.EQ.0) CALL VAPC(XMN,0.0,0.0,TYME,TMG,H,UWIND,IAC,IDIM,SIZE
     1,CHNLW,CNCNT)
      IF(INC.EQ.1) CALL CONVAP(XMN,0.0,0.0,TYME,H,FLOW,UWIND,IAC,IDIM,
     :SIZE,CHNLW,CNCNT)
      IF(CNCNT-CHAZ) 55,65,45
   45 IF(ISTP.EQ.2) GO TO 55
      SLEFT=XMN
C
C     USE GOLDEN SECTION SEARCH TO BRACKET MAX HAZARD EXTENT
C
      ISTP=1
      XMN=XMN*2.
      SRGT=XMN
      GO TO 50
   55 IF(ISTP.EQ.0) GO TO 65
C
C     USE BISECTION TECHNIQUE TO ZERO IN ON ANSWER
C
      IF(CNCNT.LE.CHAZ) SRGT=XMN
      IF(CNCNT.GT.CHAZ) SLEFT=XMN
      IF(SRGT-SLEFT-DX) 66,66,75
   66 XMN=SRGT
      GO TO 65
   75 ISTP=2
   70 XMN=((SRGT-SLEFT)/2.)+SLEFT
      GO TO 50
   65 IF(IXX.EQ.1) XFIR=XMN
      IF(IXX.EQ.2) XTOX=XMN
      IF(IXX.EQ.2) GO TO 85
      IXX=2
      IF(CTOX.EQ.0.0) XTOX=0.0
      IF(CTOX.EQ.0.0) GO TO 105
      ISTP=0
      CHAZ=CTOXX
      GO TO 81
```

```
C
C     PRINTOUT AND SAVE HAZARD EXTENTS
C
   85 IF(H.LE.1.0) GO TO 105
      IF(CCCC.LT.CFIRE) XFIR=305.
      IF(CCCC.LT.CTOXX) XTOX=305.
  105 CALL FSV(4010,XFIR,4)
      CALL FSV(4043,XTOX,4)
      CALL FSV(4069,RATIO,4)
      IF(XFIR.EQ.0.0) CALL PAGER(3)
      IF(XFIR.EQ.0.0) WRITE(LP,100)
      IF(XTOX.EQ.0.0) CALL PAGER(3)
      IF(XTOX.EQ.0.0) WRITE(LP,110)
      IF(XFIR.GT.305.0.AND.XTOX.GT.305.0) GO TO 140
      IF(XFIR.EQ.305.0) CALL PAGER(3)
      IF(XFIR.EQ.305.0) WRITE(LP,120)
      IF(XTOX.EQ.305.0) CALL PAGER(3)
      IF(XTOX.EQ.305.0) WRITE(LP,130)
  140 CALL ENDPR(MOD)
C
C     DETERMINE WHICH PLOTS OR TABLES ARE DESIRED AND PROCEED TO THE
C     APPROPRIATE SECTION OF PROGRAM
C
      IF(IC1PF.EQ.0.AND.IC2PF.EQ.0) GO TO 40
      IF(IC2PF.EQ.2) GO TO 90
      IF(IC2PF.EQ.3) GO TO 90
      IF(IC1PF.EQ.1) GO TO 90
      IF(IC1PF.EQ.3) GO TO 90
      GO TO 86
C
C         CALCULATE DATA FOR PLOT AND TABLE OF CONCENTRATION VS TIME
C     AT USER SPECIFIED POINT IF SPILL IS INSTANTANEOUS
C
   90 IF(IC2PF.NE.0.AND.IC2PF.NE.1) GO TO 91
      GO TO 92
   91 CALL PAGER(0)
      CALL PAGER(3)
      WRITE(6,95)
      CALL PAGER(1)
      WRITE(6,20)
      CALL PAGER(2)
      WRITE(6,25)
   92 CONTINUE
      IF(IDIM.EQ.1) SZ=SQRT(SIZE*CHNLW/3.14159)
      IF(IDIM.EQ.2) SZ=SIZE
      XCENT=X+(10.*SZ)
      CALL JHHDC(XCENT,IAC,SIGY,SIGZ)
      TMX=(X+(4.5*SIGY))/UWIND
      TMN=(X-(3.5*SIGY))/UWIND
      IF(TMN.LE.0.0) TMN=1.0
      DT=(TMX-TMN)/19.
      DO 10 I=1,20
      AT(I)=FLOAT(I-1)*DT+TMN
      IF(INC.EQ.1) AT(I)=(X/UWIND)+1.0
      IF(INC.EQ.0) CALL VAPC(X,Y,Z,AT(I),TMG,H,UWIND,IAC,IDIM,SIZE,
     *CHNLW,AC(I,1))
      IF(INC.EQ.1) CALL CONVAP(X,Y,Z,AT(I),H,FLOW,UWIND,IAC,IDIM,SIZE,
     *CHNLW,AC(I,1))
      IF(INC.EQ.1) GO TO 11
   10 CONTINUE
C
C     WRITE TABLE OF CONCENTRATION VS TIME AT USER SPECIFIED POINT.
C
   11 I=1
  175 ATM=AT(I)/60.
      ATH=ATM/60.
      IF(AC(I,1).GT.0.0) CALL TOXIC(AC(I,1),1,AM,XCPPM)
      IF(AC(I,1).GT.0.0) CALL TOXIC(AC(I,1),0,AM,XCMOL)
      IF(XCPPM.GT.1000000.) XCPPM=1000000.
      IF(XCMOL.GT.100.) XCMOL=100.
      IF(IC2PF.NE.0.AND.IC2PF.NE.1) GO TO 28
      GO TO 29
```

```
   28 CONTINUE
      CALL PAGER(1)
      WRITE(LP,35) ATM,ATH,XCPPM,XCMOL
   29 CONTINUE
      IF(INC.NE.1) GO TO 30
      CALL PAGER(7)
      SORTM=(SORDRN+(X/UWIND))/60.
      CALL PAGER(7)
      WRITE(6,26) SORTM
   30 CONTINUE
      IF(INC.EQ.1) GO TO 32
      I=I+1
      IF(I.EQ.21) GO TO 32
      GO TO 175
   32 CALL PAGER(4)
      WRITE(LP,31)
      CALL FRCL(2012,X,IS,IR)
      CALL FRCL(2013,Y,IS,IR)
      CALL FRCL(2014,Z,IS,IR)
      IF(IW.GE.2) CALL PAGER(4)
      IF(INC.EQ.1.AND.IW.EQ.2) WRITE(LP,94)
      IF(INC.EQ.1.AND.IW.EQ.3) WRITE(LP,96)
   86 CONTINUE
      IF(IC1PF.EQ.0) GO TO 40
      IF(IC1PF.EQ.1) GO TO 14
C
C     CALCULATE DATA FOR PLOT OF MAXIMUM GROUNDLEVEL CONCENTRATION
C     IN DOWNWIND CENTERLINE DIRECTION VS TIME AND DISTANCE
      ZZ=0.
      YY=0.
      IF(INC.EQ.1) XMN=SIZE+1.0
      IF(INC.EQ.1.AND.XMN.LT.305.) XMN=305.
      IF(INC.EQ.1) GO TO 88
      AMT=TMG/908000.
      XMN=(2.**ALOG10(AMT))*1905.
      IF(XMN.LT.SIZE) XMN=SIZE
   88 DX=ABS((XMX-XMN)/19.)
      DO 12 I=1,20
      AX(I) = (FLOAT(I-1)*DX)+XMN
      TIM=AX(I)/UWIND
      IF(INC.EQ.0) CALL VAPC(AX(I),YY,ZZ,TIM,TMG,H,UWIND,IAC,IDIM,SIZE,
     *CHNLW,AC(I,2))
      IF(INC.EQ.1) CALL CONVAP(AX(I),YY,ZZ,TIM,H,FLOW,UWIND,IAC,IDIM,SIZ
     *E,CHNLW,AC(I,2))
      IF(AC(I,2).GE.C2X)C2X=AC(I,2)
   12 CONTINUE
   14 CONTINUE
C
C         WRITE PLOT FILE
C
      DO 15 I=1,2
      IF(I.EQ.1.AND.INC.EQ.1) GO TO 15
      IF(IC1PF.EQ.2.AND.I.EQ.1) GO TO 15
      IF(IC1PF.EQ.1.AND.I.EQ.2) GO TO 15
      DO 13 II=1,20
      IF(I.EQ.1) ASAV(II)=AT(II)/60.
      IF(I.EQ.2) ASAV(II)=AX(II)/100.
      IF(AC(II,I).GT.1.) AC(II,I)=1.0
      IF(AC(II,I).GT.0.0) CALL TOXIC(AC(II,I),0,AM,ASAVC(II))
      IF(ASAVC(II).GT.100.) ASAVC(II)=100.
   13 CONTINUE
     0IF(I.EQ.1) CALL PLTLP(PTITL,ASAV,ASAVC,20,XTITL1,YTITL1,1,60.,
     1                      XTITL2)
       DIV=0.6*UWIND
     0IF(I.EQ.2) CALL PLTLP(PTIT ,ASAV,ASAVC,20,XTITL3,YTITL2,1,DIV,
     1                      XTITL4)
      CALL PAGER(4)
      WRITE(6,16)
   15 CONTINUE
C
C--------SET UP OFF-LINE PLOT
      PLTYP=3
```

```
C
   40 CONTINUE
   99 RETURN
   16 FORMAT(//35X,65H***** RESULTS IN UNITS OF MOLE PERCENT MULTIPLIED
     *BY 10,000 *****/35X,40H***** GIVE ANSWERS IN UNITS OF PPM *****)
   20 FORMAT(4X,4HTIME,9X,4HTIME,8X,8HVAP CONC,5X,8HVAP CONC)
   25 FORMAT(3X,6H(MINS),7X,6H( HRS),9X,5H(PPM),7X,7H(MOL P)/)
   26 FORMAT(//60H THE DISCHARGE IS CONTINUOUS. THE STEADY-STATE CONCENT
     1RATION/ 40H WILL THEREFORE AVERAGE THAT SHOWN UNTIL,F7.1,14H MINUT
     $ES AFTER/21H THE DISCHARGE STOPS.//)
   31 FORMAT(//45H THE LOCATION COORDINATES FOR THIS TABLE ARE-/)
   35 FORMAT(1X,E10.3,3X,E10.3,3X,E10.3,3X,E10.3)
  940 FORMAT(//1X,63H**** THIS TABLE REPLACES THE PLOT OF CONCENTRATION
     1VS TIME ****/1X,63H**** REQUESTED IN ORDER TO SAVE COMPUTATION TIM
     2E.            ****)
  950 FORMAT (56H  TABLE OF CONCENTRATION VS TIME AT USER SPECIFIED POIN
     1T//)
  960 FORMAT(//1X,63H**** SINCE A PLOT OF CONCENTRATION VS TIME WOULD NO
     1T SHOW  ****/1X,63H**** ADDITIONAL INFORMATION, ONE IS NOT PRODUCE
     2D.            ****)
 1000 FORMAT(/5X,56H*** THE MAXIMUM EXTENT OF FLAMMABLE VAPOR HAZARD IS
     1ZERO/9X,56HBECAUSE THE LOWER FLAMMABLE LIMIT CONCENTRATION IS ZERO
     2.)
 1100 FORMAT(/5X,52H*** THE MAXIMUM EXTENT OF TOXIC VAPOR HAZARD IS ZERO
     1/9X,52HBECAUSE THE LOWER TOXIC LIMIT CONCENTRATION IS ZERO.)
 1200 FORMAT(/5X,62H*** THE MINIMUM ANSWER HACS CAN GIVE IS 305 CM OR 10
     1 FEET WHEN/9X,61HTHE LOWER FLAMMABLE LIMIT CONCENTRATION IS GREATE
     2R THAN ZERO.)
 1300 FORMAT(/5X,62H*** THE MINIMUM ANSWER HACS CAN GIVE IS 305 CM OR 10
     1 FEET WHEN/9X,57HTHE LOWER TOXIC LIMIT CONCENTRATION IS GREATER TH
     2AN ZERO.)
      END
      SUBROUTINE MODC2
C
C   SUBROUTINE MODC2 OBTAINS THE NECESSARY DATA TO EXECUTE ROUTINE
C   IVAPC FOR INSTANTANEOUS SPILLS OR IVAPCN FOR CONTINUOUS SPILLS.
C   THESE ROUTINES, GIVEN HAZARDOUS VAPOR CONCENTRATIONS, CALCULATE
C   THE ARRIVAL TIME OF A HAZARDOUS CONCENTRATION, ITS DURATION, AND
C   ITS WIDTH IN THE CLOUD OR PLUME.
C
      DIMENSION ASW(20),AT(20),AX(20),ADRN(20),IIO(20)
      DATA MOD/4H C2 /
    5 CONTINUE
      IR=0
      IS=6
      LP=6
C
C          OBTAIN NECESSARY DATA ITEMS
C
      CALL BEGPR(MOD)
      CALL IRCL(2061,INC,IS,IR)
      CALL FRCL(1002,AM,IS,IR)
      CALL FRCL(2012,X,IS,IR)
      CALL FRCL(2013,Y,IS,IR)
      CALL FRCL(2015,H,IS,IR)
      CALL FRCL(2016,UWIND,IS,IR)
      CALL IRCL(2017,IAC,IS,IR)
      CALL IRCL(2018,IDIM,IS,IR)
      CALL FRCL(2019,SIZE,IS,IR)
      IF(IDIM.EQ.1) CALL FRCL(2020,CHNLW,IS,IR)
      CALL FRCL(2032,CTOX,IS,IR)
      CALL FRCL(2033,CFIR,IS,IR)
      IF(INC.EQ.0) CALL FRCL(4001,TMG,IS,IR)
      IF(INC.EQ.1) CALL FRCL(4044,FLOW,IS,IR)
      IF(INC.EQ.1) CALL FRCL(4045,SORDRN,IS,IR)
      CALL IRCL(3005,IC2PF,IS,IR)
      IF(IC2PF.EQ.0) GO TO 1
      IF(IC2PF.EQ.2) GO TO 1
      CALL FRCL(2035,XMX,IS,IR)
    1 CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 5
```

```
C   CALL IVAPC OR IVAPCN AS APPROPRIATE FOR THE HAZARD CONCENTRATIONS.
C
      IFIR=1
      IITOX=0
      IF(CTOX.GT.0.0) IITOX=1
      IF(CFIR.GT.0.0) IFIR=0
      IF(IITOX.EQ.1) CALL ITOX(CTOX,AM,IITOX,C)
      IF(IITOX.EQ.1) CTOX=C
      IF(IFIR.EQ.0) CALL ITOX(CFIR,AM,IFIR,C)
      IF(IFIR.EQ.0) CFIR=C
      DO 10 ICNT=1,2
      IF(ICNT.EQ.1) C=CTOX
      IF(ICNT.EQ.2) C=CFIR
      IF(IITOX.EQ.0.AND.ICNT.EQ.1) GO TO 10
      IF(IFIR.EQ.1.AND.ICNT.EQ.2) GO TO 10
      IF(INC.EQ.0) CALL IVAPC(TMG,UWIND,H,C,X,Y,IAC,IDIM,SW,SIZE,CHNLW,
     1TIME,DURN,IO)
      IF(INC.EQ.1) CALL IVAPCN(X,Y,0.0,H,SORDRN,FLOW,SIZE,IDIM,CHNLW,UWI
     1ND,IAC,C,SW,TIME,DURN)
      IF(TIME.LT.0.0) TIME=0.0
C
C   UPDATE DATA BASE
C
      CALL OUTPR(MOD)
      IF(ICNT.EQ.2) GO TO 9
      CALL PAGER(2)
      WRITE(LP,100)
      CALL PAGER(2)
      WRITE(6,120)
      CALL FSV(4011,SW,4)
      CALL FSV(4012,DURN,4)
      CALL FSV(4013,TIME,4)
      GO TO 10
    9 CALL PAGER(2)
      WRITE(LP,110)
      CALL PAGER(2)
      WRITE(LP,120)
      CALL FSV(4065,SW,4)
      CALL FSV(4066,DURN,4)
      CALL FSV(4067,TIME,4)
   10 CONTINUE
      IF(IITOX.EQ.0) CALL PAGER(4)
      IF(IITOX.EQ.0) WRITE(LP,150)
      IF(IFIR.EQ.1) CALL PAGER(4)
      IF(IFIR.EQ.1) WRITE(LP,160)
      CALL ENDPR(MOD)
C
C     CALCULATE DATA FOR AND WRITE TABLE OF HALF WIDTHS, ARRIVAL TIMES,
C     AND HAZARD DURATIONS IF REQUESTED.
C
      IF(IC2PF.EQ.0) GO TO 99
      IF(IC2PF.EQ.2) GO TO 99
      IF(INC.EQ.1) XMN=10.*12.*2.54
      IF(INC.EQ.1) GO TO 20
      AMT=TMG/908000.
      XMN=(2.**ALOG10(AMT))*1905.
   20 DX=(XMX-XMN)/19.
      DX=ABS(DX)
      DO 50 ICNT=1,2
      IW=0
      IF(IITOX.EQ.0.AND.ICNT.EQ.1) IW=1
      IF(IW.EQ.0) GO TO 22
      CALL PAGER(4)
      WRITE(LP,26)
      GO TO 50
   22 IF(IFIR.EQ.1.AND.ICNT.EQ.2) IW=2
      IF(IW.NE.2) GO TO 24
      CALL PAGER(4)
      WRITE(LP,28)
      GO TO 99
   24 IF(ICNT.EQ.1) C=CTOX
      IF(ICNT.EQ.2) C=CFIR
```

```
      CALL PAGER(0)
      CALL PAGER(7)
      IF(ICNT.EQ.1) WRITE(6,38)
      IF(ICNT.EQ.2) WRITE(6,39)
      WRITE(6,41)
      WRITE(6,42)
      DO 30 I=1,20
      AX(I)=XMN+FLOAT(I-1)*DX
      IF(INC.EQ.0) CALL IVAPC(TMG,UWIND,H,C,AX(I),Y,IAC,IDIM,ASW(I),SIZE
     1,CHNLW,AT(I),ADRN(I),IIO(I))
      IF(INC.EQ.1) CALL IVAPCN(AX(I),Y,0.0,H,SORDRN,FLOW,SIZE,IDIM,CHNLW
     1,UWIND,IAC,C,ASW(I),AT(I),ADRN(I))
      IF(AT(I).LT.0.0) AT(I)=0.0
      DISM=AX(I)/100.
      DISFT=AX(I)/(2.54*12.)
      ATIM=AT(I)/60.
      SWM=ASW(I)/100.
      SWFT=ASW(I)/(2.54*12.)
      DRNMN=ADRN(I)/60.
      CALL PAGER(1)
      WRITE(6,43) DISM,DISFT,ATIM,SWM,SWFT,DRNMN
   30 CONTINUE
      YM=Y/100.
      YFT=Y/(2.54*12.)
      CALL PAGER(3)
      WRITE(6,44) YM,YFT
      CALL PAGER(2)
      WRITE(6,45)
      CALL PAGER(2)
      WRITE(6,46)
   50 CONTINUE
   99 RETURN
  260FORMAT(//1X,50H**** TOXIC VAPOR CLOUD HAZARD TABLE NOT GIVEN ****/
     11X,50H**** BECAUSE 2032 LOWER TOXIC LIMIT IS ZERO.   ****)
  280FORMAT(//1X,54H**** FLAMMABLE VAPOR CLOUD HAZARD TABLE NOT GIVEN *
     1***/1X,54H**** BECAUSE 2033 LOWER FLAMMABLE LIMIT IS ZERO.   ****)
   38 FORMAT(/20X,41HTOXIC VAPOR CLOUD HAZARD TABLE - MODEL C2//)
   39 FORMAT(/18X,45HFLAMMABLE VAPOR CLOUD HAZARD TABLE - MODEL C2//)
   41 FORMAT(1X,10HX-DISTANCE,3X,10HX-DISTANCE,3X,10HARRIV TIME,3X,12H1/
     12 HAZ ZONE,3X,12H1/2 HAZ ZONE,3X,8HDURATION)
   42 FORMAT(2X,8H(METERS),6X,6H(FEET),6X,9H(MINUTES),5X,8H(METERS),8X,6
     1H(FEET),6X,9H(MINUTES)/)
   43 FORMAT(1X,G10.4,3X,G10.4,3X,G10.4,4X,G10.4,5X,G10.4,4X,G10.4)
   44 FORMAT(//15X,19HTHE Y COORDINATE = ,G10.4,5H M = ,G10.4,4H FT.)
   45 FORMAT(15X,41HTHE Z COORDINATE IS FIXED AT GROUNDLEVEL./)
  460FORMAT (15X,62HAN ARRIVAL TIME, HALF WIDTH, AND DURATION OF 0.0 IN
     1DICATES THE/15X,56HHAZARDOUS CONCENTRATION NEVER REACHES THE GIVEN
     2LOCATION.)
  100 FORMAT(1X,28HFOR THE TOXIC CONCENTRATION./)
  110 FORMAT(1X,44HFOR THE LOWER FLAMMABLE LIMIT CONCENTRATION./)
  120 FORMAT(1X,28HAT THE USER SPECIFIED POINT./)
 1500FORMAT(/5X,52H*** RESULTS FOR THE TOXIC VAPOR HAZARD ARE NOT GIVEN
     1/9X,52HBECAUSE THE LOWER TOXIC LIMIT CONCENTRATION IS ZERO./)
 1600FORMAT(/5X,56H*** RESULTS FOR THE FLAMMABLE VAPOR HAZARD ARE NOT G
     1IVEN/9X,56HBECAUSE THE LOWER FLAMMABLE LIMIT CONCENTRATION IS ZERO
     2./)
      END
      SUBROUTINE MODG
C
C     SUBROUTINE MODG CALLS THE VAPOR DISPERSION ROUTINES OF MODEL C
C     FOR SPILLS OF LIGHTER-THAN-WATER, INSOLUBLE LIQUIDS WHICH HAVE
C     BOILING POINTS LESS THAN NORMAL AMBIENT TEMPERATURES.  IF THE
C     SPILL IS INSTANTANEOUS, IT FIRST SUMS THE WEIGHT OF GAS WHICH
C     ESCAPED FROM A TANK WITH THE WEIGHT OF LIQUID WHICH ESCAPED.
C     THIS SUM IS UTILIZED IN SUBSEQUENT MODEL C CALCULATIONS.
C
C
      LP=6
      CALL PAGER(5)
      WRITE(LP,100)
C
       CALL IRCL(2061,ISPT,IS,IR)
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```
      IF(ISPT.EQ.1) GO TO 10
      CALL FRCL(4001,TMG,IS,IR)
      CALL FRCL(4002,TML,IS,IR)
      TMG=TMG+TML
      CALL PAGER(2)
      WRITE(LP,102)
      CALL FSV(4001,TMG,6)
   10 CALL MODC1
      CALL MODC2
      CALL PAGER(2)
      WRITE(LP,101)
      RETURN
  100 FORMAT(///55H MODEL G IS FUNCTIONALLY REPLACED BY MODELS C1 AND C2
     1. /)
  101 FORMAT(18H MODEL G EXECUTED./)
  102 FORMAT(72H FOR MODEL G, LET MASS OF GAS BE TOTAL OF LIQUID AND GAS
     *MASSES RELEASED./)
      END
      SUBROUTINE MODJ
C
C     SUBROUTINE MODJ CALLS THE VAPOR DISPERSION ROUTINES OF MODEL C
C     FOR SPILLS OF HEAVIER-THAN-WATER, INSOLUBLE LIQUIDS WHICH HAVE
C     BOILING POINTS LESS THAN NORMAL AMBIENT TEMPERATURES.  IF THE
C     SPILL IS INSTANTANEOUS, IT FIRST SUMS THE WEIGHT OF GAS WHICH
C     ESCAPED FROM A TANK WITH THE WEIGHT OF LIQUID WHICH ESCAPED.
C     THIS SUM IS UTILIZED IN SUBSEQUENT MODEL C CALCULATIONS.
C
C
      LP=6
      CALL PAGER(5)
      WRITE(LP,100)
C
C         OBTAIN FROM THE EXECUTION OF MODEL A TOTAL MASS GAS AND TOTAL
C         MASS LIQUID FOR USE IN MODELS C1 AND C2
C
      CALL IRCL(2061,ISPT,IS,IR)
      IF(ISPT.EQ.1) GO TO 10
      CALL FRCL(4001,TMG,IS,IR)
      CALL FRCL(4002,TML,IS,IR)
      TMG=TMG+TML
      CALL PAGER(2)
      WRITE(LP,102)
      CALL FSV(4001,TMG,6)
   10 CALL MODC1
      CALL MODC2
      CALL PAGER(2)
      WRITE(LP,101)
      RETURN
  100 FORMAT(///54H MODEL J IS FUNCTIONALLY REPLACED BY MODELS C1 AND C2
     1./)
  101 FORMAT(18H MODEL J EXECUTED./)
  1020FORMAT (73H FOR MODEL J, LET MASS OF GAS BE TOTAL OF LIQUID AND GA
     1S MASSES RELEASED./)
      END
      SUBROUTINE MODN
C
C     SUBROUTINE MODN CALLS THE VAPOR DISPERSION ROUTINES OF MODEL C
C     FOR SPILLS OF SOLUBLE LIQUIDS WITH BOILING POINTS LESS THAN
C     NORMAL AMBIENT TEMPERATURES. IT IS USUALLY PRECEDED BY THE
C     EXECUTION OF MODK. IF MODK HAS BEEN ABLE TO COMPUTE THE AMOUNTS
C     OF CHEMICAL WHICH DISSOLVE AND EVOLVE AS VAPOR, MODN DIRECTLY
C     CALLS MODEL C AFTER ASUMING THE VAPOR SOURCE IS CIRCULAR AND
C     CALCULATING A POOL RADIUS.  IF MODK HAS NOT BEEN ABLE TO COMPUTE
C     SPECIFIC AMOUNT OF CHEMICAL WHICH EVOLVES AS VAPOR, MODN
C     SUMS THE WEIGHT OF GAS RELEASED FROM THE TANK ( IF ANY )
C     WITH SOME USER SPECIFED FRACTION OF THE LIQUID WHICH IS
C     RELEASED FROM THE TANK.  THIS SUM IS THEN UTILIZED IN
C     SUBSEQUENT MODEL C CALCULATIONS.  IF THE RELEASE TAKES PLACE
C     AT A DEPTH GREATER THAN 10 FEET UNDERWATER OR THE DENSITY OF THE
C     CHEMICAL IS GREATER THAN THAT OF WATER, MODN ASSUMES THE POOL
C     RADIUS IS THE VOLUME OF THE CHEMICAL RELEASED RAISED TO THE
C     ONE-THIRD POWER.  IF THE RELEASE IS AT A DEPTH LESS THAN 10 FEET
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C     UNDERWATER AND THE DENSITY OF THE CHEMICAL IS LESS THAN THAT OF
C     WATER, MODN ASSUMES THE POOL RADIUS IS 12 TIMES THE VOLUME OF
C     CHEMICAL RELEASED RAISED TO THE ONE-THIRD POWER.
C
      DATA MOD/4H  N /
    1 CONTINUE
      LP=6
      IS=6
      IR=0
      CALL BEGPR(MOD)
      CALL FRCL(1021,DENL,IS,IR)
      CALL FRCL(2021,H,IS,IR)
      CALL FRCL(4003,VOL,IS,IR)
      IF(VOL.EQ.0.0) CALL FRCL(4002,TML,IS,IR)
      IF(VOL.EQ.0.0) VOL=TML/DENL
      CALL IRCL(2084,IFLAG,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(4001,TMG,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(4002,TML,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(2085,PERC,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
      CALL PAGER(2)
      WRITE(LP,10)
      IF(IFLAG.NE.1) GO TO 5
      TMG=TMG+(PERC*TML)
      CALL PAGER(4)
      WRITE(LP,20) PERC
      CALL FSV(4001,TMG,6)
    5 CALL PAGER(3)
      WRITE(LP,30)
      CALL ISV(2018,2,4)
      SIZE=VOL**0.333333
      IF(H.LT.304.8.AND.DENL.LT.1.0) SIZE=12.*VOL**0.333333
      CALL FSV(2019,SIZE,2)
      CALL MODC1
      CALL MODC2
      CALL ENDPR(MOD)
   99 RETURN
   10 FORMAT(/54H MODEL N IS FUNCTIONALLY REPLACED BY MODELS C1 AND C2.)
   20 FORMAT(/63H FOR MODEL N, IT IS ASSUMED THAT THE MASS OF GAS EVOLVE
     1D IS THE/26H MASS OF GAS EVOLVED PLUS ,F6.3,1X,34HTIMES THE MASS O
     1F LIQUID RELEASED./)
   30 FORMAT(/81H THE FOLLOWING VAPOR SOURCE PARAMETERS ARE ESTIMATED FO
     1R USE BY MODELS C1 AND C2./)
      END
      SUBROUTINE MODS
C
C     SUBROUTINE MODS CALLS THE VAPOR DISPERSION ROUTINES OF MODEL C
C     FOR SPILLS OF SOLUBLE LIQUIDS WITH HIGH VAPOR PRESSURES.
C
C
      LP=6
      CALL PAGER(2)
      WRITE(LP,10)
      CALL MODC1
      CALL MODC2
   10 FORMAT(/54H MODEL S IS FUNCTIONALLY REPLACED BY MODELS C1 AND C2.)
      RETURN
      END
      SUBROUTINE MODW
C
C     SUBROUTINE MODW CALLS THE VAPOR DISPERSION ROUTINES OF MODEL C
C     FOR SPILLS OF LIGHTER-THAN-WATER, INSOLUBLE LIQUIDS WHICH ARE
C     VOLATILE AT NORMAL AMBIENT TEMPERATURES.  IF THE VAPOR RELEASE IS
C     ESTIMATED TO BE BEST REPRESENTED AS BEING INSTANTANEOUS, IT
C     COMPUTES THE AMOUNT OF LIQUID WHICH HAS EVAPORATED UP TO THE USER
C     SPECIFIED TIME OR THE TIME AT WHICH EVAPORATION STOPS AND PROVIDES
C     THIS VALUE TO MODEL C.  FOR CONTINUOUS RELEASES, THE MODEL C
C     ROUTINES USE THE VAPOR EVOLUTION RATES COMPUTED BY MODEL V.
C     MODW ALSO TRANSFERS THE POOL SIZE COMPUTED BY MODEL V FROM FIELD
C     NUMBER 4027 TO 2019.
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C
      LP=6
      CALL PAGER(5)
      WRITE(LP,100)
      CALL IRCL(2061,ISPT,IS,IR)
      IF(ISPT.EQ.1) GO TO 10
      CALL FRCL(1004,DENL,IS,IR)
      CALL FRCL(4026,VOL,IS,IR)
      CALL FRCL(4003,VOLI,IS,IR)
      VAPOR=(VOLI-VOL)*DENL
      CALL PAGER(3)
      WRITE(LP,102)
      CALL FSV(4001,VAPOR,6)
C
C         OBTAIN FROM DATA BASE FOR USE IN MODEL C1 AND C2 THE SIZE OF
C         SPILL AS CALCULATED BY MODEL V
C
   10 CALL PAGER(2)
      WRITE(LP,200)
      CALL FRCL(4027,S,IS,IR)
      CALL FSV(2019,S,6)
      CALL MODC1
      CALL MODC2
      WRITE(LP,101)
      RETURN
  100 FORMAT(///54H MODEL W IS FUNCTIONALLY REPLACED BY MODELS C1 AND C2
     1./)
  101 FORMAT(18H MODEL W EXECUTED./)
  102 FORMAT(1X,57HFOR MODEL W, LET WEIGHT OF VAPOR WHICH IS ESTIMATED T
     1O BE/1X,58HRELEASED INSTANTANEOUSLY BE THE WEIGHT WHICH HAS VAPORI
     2ZED/1X,53HUP TO TIME 4030 EVP TIM HVPL GIVEN IN MODEL V OUTPUT.)
  200 FORMAT(44H USE SIZE OF SPILL AS CALCULATED BY MODEL V./)
      END
      SUBROUTINE VAPC(X,Y,Z,T,TMG,H,UWIND,IAC,IDIM,SIZE,CHNLW,C)
C***********************************************************************
C
C ***  VAPOR DISPERSION FOR MODEL C    *******
C  *** THIS SUBROUTINE CALCULATES THE DOWNWIND DISPERSION OF VAPOR CAUSE
C      BY A VAPOR LEAK FROM A TANK OR VAPOR LIBERATION FROM A POOL OF LI
C      IT IS ASSUMED THAT ALL THE GAS COMES OUT FROM A POINT SOURCE, IN
C      OF A PUFF (INSTANTANEOUSLY). THIS POINT IS ASSUMED TO BE LOCATED
C      POSITION OF THE HOLE IN THE TANK OR FIVE DIAMETERS BEHIND THE POO
C      THE CASE MAY BE.
C
C **********  INPUT ARGUMENTS  **********
C  ***        X = WIND DIRECTION CO-ORDINATE                    CMS
C  ***        Y = CROSS WIND CO-ORDINATE                        CMS
C  ***        Z = HEIGHT COORDINATE                             CMS
C  ***        T = TIME AFTER THE SPILL /LEAK AT WHICH THE CONCN IS DESIRE
C  ***      TMG = TOTAL MASS OF THE GAS RELEASED                GMS
C  ***        H = HEIGHT OF THE CENTER LINE OF THE HOLE ABOVE GROUND
C  ***    UWIND = WIND VELOCITY                                 CM/SEC
C  ***      IAC = ATMOSPERIC CONDITION AS DEFINED IN SUBROUTINE JHHDC
C  ***     IDIM = DIMENSION OF SPILL (1 IF ONE DIMENSIONAL,2 IF RADIAL)
C  ***     SIZE = MAXIMUM RADIUS/LENGTH OF POOL                 CMS
C  ***    CHNLW = CHANNEL WIDTH (REQUIRED FOR IDIM=1 ONLY)      CMS
C **********  OUTPUT ARGUMENTS  **********
C  ***        C = VAPOR CONCENTRATION                           GMS/CM**3
C
C***********************************************************************
C
      PI=3.14159256
      IF(IDIM-1) 10,10,20
   10 A=SIZE*CHNLW
      SIZE=SQRT(A/PI)
   20 FACT=10.*SIZE
      XC=UWIND*T
      XC=XC+FACT
      CALL JHHDC(XC,IAC,SIGY,SIGZ)
      SIGX=SIGY
      C1=(TMG/((2.*PI)**1.5*SIGX*SIGY*SIGZ))
      A1=EXP(-(Z-H)**2/(2.*SIGZ**2))
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      A2=EXP(-(Z+H)**2/(2.*SIGZ**2))
      C3=C1*A2
      C2=C1*A1
      C0=C2+C3
      C=C0*EXP(-(X-UWIND*T)**2/(2.*SIGX**2))*EXP(-Y**2/(2.*SIGY**2))
      IF(IDIM-1) 30,30,40
   30 SIZE=A/CHNLW
   40 RETURN
      END
      OVERLAY(6,0)
      PROGRAM MODD
C
C     MODD IS USED TO CALCULATE THE SIZE OF A POOL AS A FUNCTION OF
C     TIME AND THE TIME IT WILL TAKE FOR THE POOL TO COMPLETELY
C     VAPORIZE.  IT IS USED FOR LIGHTER-THAN-WATER, INSOLUBLE CHEMICALS
C     WITH A BOILING POINT LESS THAN THE AMBIENT TEMPERATURE.
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      DIMENSION SIZ(20),TIM(20),ASAV(20)
      DIMENSION PTITL(6),XTITL(6),XTITL1(6),YTITL(6)
      EQUIVALENCE (XBX(1),TIM(1)),(XBX(41),SIZ(1)),(XBX(21),ASAV(1))
      REAL KC,KHIC
     0DATA (PTITL (I),I=1,6)/8HPOOL RAD,8HIUS/LENG,8HTH VS TI,
     18HME - MOD,8HEL D     ,1H /
     0DATA (XTITL (I),I=1,6)/8HELAPSED ,8HTIME....,8H........,
     18H........,8H.......(,8HSECONDS)/
     0DATA (XTITL1(I),I=1,6)/8HELAPSED ,8HTIME....,8H........,
     18H........,8H.......(,8HMINUTES)/
     0DATA (YTITL (I),I=1,6)/8HPOOL RAD,8HIUS     ,8HOR LENGT,
     18HH       ,8H(METERS),1H /
      DATA MOD/4H D  /
    1 CONTINUE
C
      CALL TRACE(0,6,0)
      IR=0
      IS=6
      LP=6
C
C         OBTAIN NECESSARY DATA ITEMS
C
      CALL BEGPR(MOD)
      CALL IRCL(2060,ISPT,IS,IR)
      CALL FRCL(1003,TCRY,IS,IR)
      IF(ISPT.EQ.0) CALL FRCL(1005,VISL,IS,IR)
      CALL FRCL(1014,HLATL,IS,IR)
      CALL FRCL(1021,DENL,IS,IR)
      IF(DENL-1.0) 40,30,30
   30 CONTINUE
      CALL PAGER(6)
      WRITE(LP,100)
      DENL=0.99
   40 CONTINUE
      IF(ISPT.EQ.1) CALL FRCL(2008,DIA,IS,IR)
      IF(ISPT.EQ.0) CALL FRCL(2020,CHNLW,IS,IR)
      IF(ISPT.EQ.0) CALL IRCL(2022,IQ,IS,IR)
      CALL FRCL(2023,TINF,IS,IR)
      CALL COMPQ(TINF,TCRY,Q)
      CALL FSV(2024,Q,4)
      CALL FRCL(2024,Q,IS,IR)
      IF(ISPT.EQ.1) CALL FRCL(2026,TIME,IS,IR)
      IF(ISPT.EQ.1) CALL FRCL(2059,HGT,IS,IR)
      IF(ISPT.EQ.0) CALL FRCL(4003,VI,IS,IR)
      IF(ISPT.EQ.0.AND.VI.EQ.0.0) CALL FRCL(4002,SPAMT,IS,IR)
      IF(ISPT.EQ.0.AND.VI.EQ.0.0) VI=SPAMT/DENL
      IF(ISPT.EQ.1) CALL FRCL(4049,FLOW,IS,IR)
      IF(ISPT.EQ.1) CALL FRCL(4050,ENDTM,IS,IR)
      CALL IRCL(3006,IP,IS,IR)
      CALL IRCL(3013,ITAB,IS,IR)
      ICNT=0
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
```

```
      IF(IL.EQ.2) GO TO 1
      IF(ISPT.EQ.1) GO TO 80
      TIME=10.0
   70 ITC=1
      IDIM=2
      CALL CRYSP(IDIM,IQ,Q,VI,DENL,VISL,HLATL,TCRY,TINF,CHNLW,TIME,ITC,
     *TOWC,KC,KHIC,VOL,SIZE,SIZMX,TEVAP)
      IF(SIZMX.EQ.0.0) TIME=TEVAP/2.
      IF(SIZMX.EQ.0.0) ICNT=ICNT+1
      IF(SIZMX.EQ.0.0.AND.ICNT.EQ.1) GO TO 70
      DIAM=2.*SIZMX
      IF(DIAM.LE.CHNLW) GO TO 16
      IDIM=1
      ITC=1
      CALL CRYSP(IDIM,IQ,Q,VI,DENL,VISL,HLATL,TCRY,TINF,CHNLW,TIME,ITC,
     *TOWC,KC,KHIC,VOL,SIZE,SIZMX,TEVAP)
   16 DIAM=2.*SIZMX
      IF(IDIM.EQ.1) DIAM=SQRT(SIZMX*CHNLW*4./3.14159)
      SAVSZ=SIZMX
      GO TO 20
   80 IDIM=2
      CALL DSPRD(DENL,DIA,HGT,FLOW,Q,HLATL,TIME,SIZE,TMAX,SIZMX)
      DIAM=2.*SIZMX
C
C     UPDATE DATA BASE WITH OUTPUT
C
   20 CONTINUE
      CALL OUTPR(MOD)
      IF(IDIM.NE.2) GO TO 84
      CALL PAGER(1)
      WRITE(LP,50)
      GO TO 86
   84 IF(IDIM.NE.1) GO TO 86
      CALL PAGER(1)
      WRITE(LP,60)
   86 CONTINUE
      CALL ISV(2018,IDIM,4)
      IF(ISPT.EQ.0) SIZE=SIZMX
      CALL FSV(2019,SIZE,4)
      CALL FRCL(2019,SIZE,IS,IR)
      IF(ISPT.EQ.0) CALL FSV(4016,TEVAP,4)
      CALL FSV(4007,DIAM,4)
      CALL PAGER(3)
      WRITE(LP,81)
      CALL FSV(4068,TCRY,4)
      IND=0
      IF(ISPT.EQ.1) IND=1
      IF(IND.EQ.1) CALL ISV(2061,IND,4)
      IF(IND.EQ.1) CALL FSV(4044,FLOW,4)
      IF(IND.EQ.1) CALL FSV(4045,ENDTM,4)
      IF(ISPT.EQ.0.AND.TEVAP.GE.600.) IND=2
      IF(IND.EQ.2) FLW=VI*DENL/TEVAP
      IF(IND.EQ.2) CALL ISV(2061,1,4)
      IF(IND.EQ.2) CALL FSV(4044,FLW,4)
      IF(IND.EQ.2) CALL FSV(4045,TEVAP,4)
      IF(IND.EQ.0) CALL ISV(2061,0,4)
      IF(IDIM.EQ.2) SIZE=.5*DIAM
      IF(IDIM.EQ.1) SIZE=DIAM*DIAM*3.14159/(4.*CHNLW)
      CALL PAGER(2)
      WRITE(LP,200)
      SIZE=.707*SIZE
      CALL FSV(2019,SIZE,6)
      CALL ENDPR(MOD)
   90 IF(IP.EQ.0.AND.ITAB.EQ.0) GO TO 99
C
C     CALCULATE DATA FOR PLOT AND/OR TABLE OF POOL SIZE VS TIME
C     IF REQUESTED.
C
   91 IF(ISPT.EQ.0) DT=TEVAP/20.
      IF(ISPT.EQ.1) DT=ENDTM/20.
      IDIM=2
      STM=0.0
```

```
      ITC=1
      DO 10 I=1,20
      TIM(I)=(FLOAT(I-1)*DT)+DT
   11 IF(ISPT.EQ.0) CALL CRYSP(IDIM,IQ,Q,VI,DENL,VISL,HLATL,TCRY,TINF,
     *CHNLW,TIM(I),ITC,TOWC,KC,KHIC,VOL,SIZ(I),SIZMX,TEVP)
      IF(ISPT.EQ.1) CALL DSPRD(DENL,DIA,HGT,FLOW,Q,HLATL,TIM(I),SIZ(I),
     *TMAX,SIZMX)
      D=2.*SIZ(I)
      IF(ISPT.EQ.1) GO TO 10
      IF(IDIM.EQ.2.AND.D.GT.CHNLW) IDIM=1
      IF(STM.EQ.0.0.AND.D.GT.CHNLW) ITC=1
      IF(STM.EQ.0.0.AND.D.GT.CHNLW) STM=TIM(I)
      IF(STM.EQ.DT.AND.ITC.EQ.1) GO TO 11
   10 CONTINUE
      IF(ISPT.EQ.1) GO TO 12
      DIFFR=ABS(SIZ(20)-SAVSZ)
      IF(DIFFR.GT.3.) SIZ(20)=SAVSZ
      IF(DIFFR.GT.3.) STM=TEVAP
   12 CONTINUE
C
C         WRITE PLOT FILE
C
      IF(IP.EQ.0) GO TO 19
      DO 15 I=1,20
   15 ASAV(I)=SIZ(I)/100.
      CALL PLTLP(PTITL,TIM,ASAV,20,XTITL,YTITL,1,60.,XTITL1)
      IF(STM.EQ.0.0.OR.ISPT.EQ.1) GO TO 17
      CALL PAGER(2)
      WRITE(LP,27) STM
   17 CONTINUE
C
C--------SET UP OFF-LINE PLOT
      PLTYP=5
C
C     WRITE TABLE OF SIZE VS TIME IF REQUESTED.
C
      IF(ITAB.EQ.0) GO TO 99
   19 CONTINUE
      CALL PAGER(0)
      CALL PAGER(8)
      WRITE(LP,21)
      WRITE(LP,22)
      WRITE(LP,23)
      DO 25 I=1,20
      TMNS=TIM(I)/60.
      SM=SIZ(I)/100.
      SFT=SIZ(I)/(2.54*12.)
      CALL PAGER(1)
      WRITE(LP,24) TIM(I),TMNS,SIZ(I),SM,SFT
   25 CONTINUE
      IF(ISPT.NE.1) GO TO 92
      CALL PAGER(1)
      WRITE(LP,26)
   92 CONTINUE
      IF(STM.EQ.0.0.OR.ISPT.EQ.1) GO TO 99
      CALL PAGER(2)
      WRITE(LP,27) STM
      GO TO 99
   21 FORMAT(/21X,27HPOOL SIZE VS TIME - MODEL D//)
   22 FORMAT( 8X,4HTIME,8X,4HTIME,8X,4HSIZE,8X,4HSIZE,8X,4HSIZE)
   23 FORMAT( 7X,6H(SECS),6X,6H(MINS),7X,5H(CMS),8X,3H(M),8X,4H(FT)//)
   24 FORMAT( 5X,G10.4,2X,G10.4,2X,G10.4,2X,G10.4,2X,G10.4,2X,G10.4)
   26 FORMAT(6X,41HNOTE - THE POOL IS ASSUMED TO BE CIRCULAR)
   27 FORMAT(/17X,34H*** NOTE - AT APPROXIMATELY TIME =,G10.4,10H SECS,
     1***/17X,45H*** THE POOL IS CONFINED BY CHANNEL BANKS ***)
   50 FORMAT(29H THE SPILL POOL IS CIRCULARO )
   60 FORMAT(46H THE SPILL POOL IS CONFINED BY CHANNEL BANKSO )
   81 FORMAT( 49H IN CASE MODEL G FOLLOWS, VAPOR SOURCE PARAMETERS/24H A
     1RE ESTIMATED AS BEING-)
  100 FORMAT(/1X,68HWARNING - THE LIQUID DENSITY OF THE SPILLED CHEMICAL
     *  IS SO CLOSE TO/ 1X,68HWATER THAT IT MAY OR NOT FLOAT. FOR MODEL
     *D, IT WILL BE ASSUMED THAT/ 1X,29HTHE DENSITY IS 0.99 GM/CM**3.//)
```

```
  200 FORMAT(/60H DIM SPILL IS SET TO MEAN POOL SIZE IN CASE MODEL S FOL
     *LOWS.)
   99 CONTINUE
      CALL TRACE(1,6,0)
      END
      SUBROUTINE COMPQ(TINF,TCRY,Q)
C
C     THIS SUBROUTINE CALCULATES THE HEAT FLUX BETWEEN WATER AND A
C     LIQUID WHOSE BOILING POINT IS LESS THAN AMBIENT. THE ESTIMATION
C     IS KNOWN TO BE CORRECT ONLY FOR LIQUEFIED NATURAL GAS.  THE
C     FLUXES FOR OTHER SUBSTANCES ARE COMPUTED BY ASSUMING THAT  THEIR
C     HEAT TRANSFER COEFFICIENTS ARE EQUAL TO THE EXPERIMENTALLY
C     DETERMINED HEAT FLUX FOR LNG DIVIDED BY THE DIFFERENCE IN
C     TEMPERATURE BETWEEN LNG AND WATER AT 20 DEGREES CENTIGRADE.
C
C
C  ***  INPUTS
C
C     TINF    WATER TEMPERATURE,DEGREES C
C     TCRY    BOILING TEMPERATURE OF LIQUID,DEGREES C
CC
C  ***  OUTPUTS
C     Q             HEAT FLUX,CAL/SEC-CM**2.
C
      Q=(2.5/181.)*ABS(TINF-TCRY)
      RETURN
      END
      SUBROUTINE CRIT(I,ITC,GAM,DEL,TOWC,KHIC,KC)
C
C***********************************************************************
C
C
C     THIS SUBROUTINE CALCULATES THE CRITICAL TIME, CRITICAL VOLUME AND
C     THE CRITICAL SIZE OF SPREAD FOR SUBSTANCES OF THE TYPE ADDRESSED
C     BY MODEL D.  CRITICALITY IS DEFINED AS THE INSTANT IN TIME AT
C     WHICH THE GRAVITY INERTIA SPREAD CHANGES OVER TO THE GRAVITY
C     VISCOUS REGIME.  FOR MORE DETAILS SEE THE  TECHNICAL REPORT
C     WHICH DESCRIBES THE WORKINGS OF MODEL D.  THE NOMENCLATURE USED
C     IN THIS ROUTINE FOR THE VARIOUS QUANTITIES IS THE SAME AS THAT
C     USED IN THE TECHNICAL REPORT.
C
C
C***********************************************************************
C
      REAL K,KC,KHI,KHIC,KHIMX
      IF(ITC-1) 5,1,5
C **     TOW=5. IS ARBITRARILY SET TO FIRST FIND OUT THE TIME FOR COMPLE
1     TOW=5.
      CALL GRSPD(I,TOW,DEL,KHI,K,ETA,TOWEN,KHIMX)
      DTOW=TOWEN/100.
      TOW=TOWEN
2     TOW=TOW-DTOW
      CALL GRSPD(I,TOW,DEL,KHI,K,ETA,TOWEN,KHIMX)
      BLT=SQRT(TOW)/GAM
      E=ETA-BLT
      IF(E) 3,4,4
3     E1=E
      GO TO 2
4     TOWC=TOW+DTOW*E/(E+ABS(E1))
      CALL GRSPD(I,TOWC,DEL,KHIC,KC,ETA,TOWEN,KHIMX)
5     RETURN
      END
      SUBROUTINE CRYSP(IDIM,IQ,Q,VI,DENL,VISL,HLATL,TCRY,TINF,CHNLW,TIME
     1,ITC,TOWC,KC,KHIC,VOL,SIZE,SIZMX,TEVAP)
C
C***********************************************************************
C
C
C     CRYSP STANDS FOR SPREAD OF A CRYOGEN.  THIS ROUTINE GIVES THE
C     EXTENT OF SPREAD, VOLUME OF LIQUID REMAINING, MAX SIZE, AND
C    THE TIME FOR COMPLETE EVAPORATION FOR THE SPREAD OF A CRYOGEN
C     ON WATER.  THE NOMENCLATURE USED FOR THE VARIOUS PARAMETERS IS THE
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C     SAME AS THAT USED IN THE TECHNICAL REPORT WHICH DESCRIBES HOW
C     MODEL D WAS DEVELOPED.
C
C  ***************INPUT PARAMETERS***************
C     IDIM       =A FLAG INDICATING WHETHER THE POOL SPREADS RADIALLY
C                 OR IS CONFINED BY CHANNEL BANKS. 1 MEANS IT IS CONFINED
C                 BY CHANNEL BANKS. 2 MEANS IT SPREADS RADIALLY.
C     IQ         =FLAG WHICH SPECIFIES WHETHER THE HEAT TRANSFER IS
C                 LIMITED BY ICE FORMATION UNDER THE SPREADING LIQUID
C                 OR WHETHER IT IS CONSTANT. 1 IS FOR CONSTANT HEAT.
C                 2 IS FOR ICE FORMATION.
C     Q          =VALUE OF THE CONSTANT HEAT FLUX IF IQ=1,CAL/CM**2-SEC
C     VI         =INITIAL VOLUME OF SPILLED LIQUID, CM**3
C     DENL       =DENSITY OF LIQUID, G/CM**3
C     VISL       =VISCOSITY OF SPILLED LIQUID, G/CM-SEC
C     HLATL      =LATENT HEAT OF EVAPORATION OF LIQUID, CAL/G
C     TCRY       =TEMPERATURE OF SPILLED LIQUID, DEG C
C     TINF       =TEMPERATURE OF WATER FAR FROM SPILL INTERFACE,DEG C
C     CHNLW      =WIDTH OF THE CHANNEL WHERE SPILL OCCURS, CM
C                 (REQUIRED ONLY IF SPILL POOL IS CONFINED)
C     TIME       =TIME AT WHICH  OUTPUT PARAMETERS ARE DESIRED, SEC
C     ITC        =A FLAG INDICATING WHETHER CERTAIN CALCULATIONS
C                 ARE DESIRED. BY SETTING THIS FLAG TO 1 THE FIRST
C                 TIME THROUGH THE ROUTINE, THESE VALUES ARE COMPUTED.
C                 THEREAFTER, THE FLAG SHOUD BE SET TO SOME OTHER
C                 VALUE TO PREVENT THESE CERTAIN PARAMETERS FROM BEING
C                RECALCULATED. THIS SAVES CPU TIME IN ITERATION
C                 FOR PLOT AND TABLE ARRAY DEVELOPMENT.
C
C***************OUTPUT PARAMETERS******************
C
C     TOWC       = DIMENSIONLESS TIME AT WHICH THE SPREAD CHANGES
C                 REGIMES
C     KC         =DIMENSIONLESS VOLUME AT CRITICAL TIME TOWC
C     KHIC       =DIMENSIONLESS CRITICAL SPREAD EXTENT
C     VOL        =VOLUME OF LIQUID REMAINING AT SPECIFIED TIME, CM**3
C     SIZE       =EXTENT OF SPREAD AT SPECIFIED TIME, CM
C                 (RADIUS OR LENGTH OF CHANNEL COVERED DEPENDING
C                 UPON THE VALUE OF IDIM GIVEN AS INPUT)
C     SIZMX      =MAX POOL SIZE  (RADIUS OR LENGTH AS ABOVE), CM
C     TEVAP      =TIME FOR ALL LIQUID TO EVAPORATE, SEC
C
C
C*********************************************************************
C
      REAL K,KC,KHI,KHIC,KHIM,KICE,L,KHIMX
      DATA CPI,TF/0.502,0.0/
      DATA GR,PI,KICE,VISW,HLATI,DENI,DENW/980 .,3.14159265,0.005,0.01,
     180.,0.92,1.0/
      G=GR*(1.-DENL/DENW)
      GAML=(VI*G/(VISL/DENL)**2)**0.25
      GAMW=(VI*G/(VISW/DENW)**2)**0.25
      L=VI**(1./3.)
      IF(IDIM-1) 1,1,2
1     L=SQRT(0.5*VI/CHNLW)
      HFSEF=HLATI+(TINF-TF)+0.5*CPI*(TF-TCRY)
      ALFAP=SQRT((KICE*(TF-TCRY)*DENI*HFSEF)/(((HLATL*DENL)**2)*SQRT(VI*
     1G)))
      ALFA=2.*PI*ALFAP
      BETA=(PI/2.)*ALFAP
2     CHTM=SQRT(L/G)
      DEL=Q/(HLATL*DENL*(L/CHTM))
C  ****  SPREAD CALCULATIONS BEGIN *****
      TOW=TIME/CHTM
      GO TO (3,14),IDIM
3     GO TO (4,11),IQ
C ***  ONE DIMENSION SPREAD WITH CONSTANT HEAT FLUX ****
4     I=1
      IF(VISL-0.5*VISW) 8,5,5
5     CALL CRIT(I,ITC,GAMW,DEL,TOWC,KHIC,KC)
      TOWE=TOWC*(1.+1.375*KC/(TOWC*KHIC*DEL))*(8./11.)
      KHIM=KHIC*(TOWE/TOWC)**0.375
```

```
      IF(TOW-TOWC) 6,6,7
6     CALL GRSPD(I,TOW,DEL,KHI,K,ETA,TOWEN,KHIMX)
      GO TO 1000
7     KHI=KHIC*(TOW/TOWC)**0.375
      K=KC-(TOWC*KHIC*DEL/1.375)*((TOW/TOWC)**1.375-1.)
      GO TO 1000
8     CALL CRIT(I,ITC,GAML,DEL,TOWC,KHIC,KC)
      TOWE=TOWC*(1.+1.2*KC/(TOWC*KHIC*DEL))**(5./6.)
      KHIM=KHIC*(TOWE/TOWC)**0.2
      IF(TOW-TOWC) 9,9,10
9     CALL GRSPD(I,TOW,DEL,KHI,K,ETA,TOWEN,KHIMX)
      GO TO 1000
10    KHI=KHIC*(TOW/TOWC)**0.2
      K=KC-(TOWC*KHIC*DEL/1.2)*((TOW/TOWC)**1.2-1.)
      GO TO 1000
C ***  ICE FORMATION  **** ONE DIMENSIONAL SPREAD ****
11    I=2
      CALL CRIT(I,ITC,GAML,BETA,TOWC,KHIC,KC)
      TOWE=TOWC*(1.+0.7*KC/(BETA*KHIC*SQRT(TOWC)))**(10./7.)
      KHIM=KHIC*(TOWE/TOWC)**0.2
      IF(TOW-TOWC) 12,12,13
12    CALL GRSPD(I,TOW,BETA,KHI,K,ETA,TOWEN,KHIMX)
      GO TO 1000
13    KHI=KHIC*(TOW/TOWC)**0.2
      K=KC-(10.*BETA/7.)*KHIC*SQRT(TOWC)*((TOW/TOWC)**0.7-1.)
      GO TO 1000
C
C  ****** RADIAL SPREAD  ******** CONSTANT HEAT FLUX  ******
14    GO TO (15,22),IQ
15    I=3
      IF(VISL-VISW*0.5) 19,16,16
16    CALL CRIT(I,ITC,GAMW,DEL,TOWC,KHIC,KC)
      TOWE=TOWC*(1.+1.5*KC/(PI*TOWC*DEL*KHIC**2))**(2./3.)
      KHIM=KHIC*(TOWE/TOWC)**0.25
      IF(TOW-TOWC) 17,17,18
17    CALL GRSPD(I,TOW,DEL,KHI,K,ETA,TOWEN,KHIMX)
      GO TO 1000
18    KHI=KHIC*(TOW/TOWC)**0.25
      K=KC-((DEL*PI/1.5)*TOWC*KHIC**2)*((TOW/TOWC)**1.5-1.)
      GO TO 1000
19    CALL CRIT(I,ITC,GAML,DEL,TOWC,KHIC,KC)
      TOWE=TOWC*(1.+1.25*KC/(PI*TOWC*DEL*KHIC**2))**0.8
      KHIM=KHIC*(TOWE/TOWC)**0.125
      IF(TOW-TOWC) 20,20,21
20    CALL GRSPD(I,TOW,DEL,KHI,K,ETA,TOWEN,KHIMX)
      GO TO 1000
21    KHI=KHIC*(TOW/TOWC)**0.125
      K=KC-(DEL*PI/1.25)*TOWC*KHIC**2*((TOW/TOWC)**1.25-1.)
      GO TO 1000
22    I=4
      CALL CRIT(I,ITC,GAML,ALFA,TOWC,KHIC,KC)
      TOWE=TOWC*(1.+0.75*KC/(PI*ALFA*KHIC**2*SQRT(TOWC)))**(4./3.)
      KHIM=KHIC*(TOWE/TOWC)**0.125
      IF(TOW-TOWC) 23,23,24
23    CALL GRSPD(I,TOW,ALFA,KHI,K,ETA,TOWEN,KHIMX)
      GO TO 1000
24    KHI=KHIC*(TOW/TOWC)**0.125
      K=KC-(4.*PI*ALFA*TOWC*KHIC**2/3.)*((TOW/TOWC)**0.75-1.)
C  ******   CONVERSION TO DIMENSIONAL UNITS  ******
1000  VOL=K*VI
      SIZE=FLOAT(3-IDIM)*L*KHI
      SIZMX=FLOAT(3-IDIM)*L*KHIM
      TEVAP=TOWE*CHTM
      ITC=0
      RETURN
      END
      SUBROUTINE DSPRD(DENL,DIA,HGT,FLOW,Q,HTVAP,TIME,SIZE,TMAX,SIZMX)
C
C**********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE POOL SIZE VERSUS TIME FOR A
C     CONTINUOUS DISCHARGE OF A LIGHTER-THAN-WATER INSOLUBLE LIQUID
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```
C     WITH BOILING POINT LESS THAN AMBIENT.  IT WORKS ONLY FOR RADIAL
C     SPREADING.
C
C  *** INPUTS ***
C
C     DENL  DENSITY OF DISCHARGED LIQUID                    GM/CM**3
C     DIA   DIAMETER OF HOLE                                CM
C     HGT   HEIGHT OF HOLE ABOVE WATER                      CM
C     FLOW  MASS RATE OF FLOW OF DISCHARGED SUBSTANCE       GM/SEC
C     Q     HEAT FLUX BETWEEN WATER AND CHEMICAL POOL       CAL/SEC-CM**2
C     HTVAP HEAT OF VAPORIZATION OF DISCHARGED LIQUID       CAL/GM
C     TIME  ELAPSED TIME AFTER SPILL STARTS AT WHICH
C           POOL SIZE IS DESIRED                            SECS
C
C  *** OUTPUTS ***
C
C     SIZE  RADIUS OF POOL AT SPECIFIED TIME                CM
C     TMAX  TIME AT WHICH POOL REACHES MAXIMUM RADIUS       SECS
C     SIZMX MAXIMUM RADIUS POOL WILL ATTAIN                 CM
C
C***********************************************************************
C
      REAL K,KHIMX
      PI=3.141592654
      G=980.
      DENW=1.0
C
C     CALCULATING THE JET ENTRY PARAMETERS, HYDRAULIC PUMP RADIUS
C     AND THE RADIAL OUTFLOW VELOCITY.
C
      FLW=FLOW/DENL
      GRAV=G*(1.-DENL/DENW)
   10 RN=DIA/2.
      VEL=FLW/((PI/4.)*DIA*DIA)
      FDJET=VEL*VEL/(GRAV*(DIA/2.))
      U=SQRT((VEL**2.)+(2.*G*HGT))
      A=DIA*SQRT(VEL/U)/2.
      HB=A/2.
      FB=2.*U*U/(GRAV*A)
      FA=8.*FB/((SQRT((8.*FB)+1.)-1.)**3.)
      HA=HB*(FB/FA)**(1./3.)
      UA=U*HB/HA
C
C     CALCULATING THE RADIAL SPREAD PARAMETERS.
C
      TCH=A/UA
      TAU=TIME/TCH
      F=UA*UA/(HA*GRAV)
      E1=0.41
      E0=0.68
C
C     CRYOGENIC SPREADING ANALYSIS
C     CALCULATION OF PARAMETERS
C
      YDOT=Q/(HTVAP*DENL)
      GAMMA=A*YDOT/(2.*UA*HA)
      TCH=A/UA
      K=E1*F/(1.-2.*E1)**2
      C=SQRT(2./(1.-2.*E1))
      EPSILN=K*GAMMA*C*C
C
C     MAXIMUM SPREAD CALCULATION
C
      KHIMX=SQRT(1./GAMMA)
      TOWBMX=1.6/EPSILN
      TMAX=K*TCH*TOWBMX
      SIZMX=A*KHIMX
      IF(TIME.LT.TMAX) GO TO 40
      SIZE=SIZMX
      RETURN
   40 TOWBAR=TIME/(K*TCH)
      ETOWB=EPSILN*TOWBAR
```

```
      SIGMA=TOWBAR*((1./6.)*ETOWB*ETOWB-0.5*ETOWB+1.)
      PSI=C*SQRT(SIGMA*K)
      SIZE=(1.+PSI)*A
      RETURN
      END
      SUBROUTINE GRSPD(I,TOW,DEL,KHI,K,ETA,TOWEN,KHIMX)
C***********************************************************************
C
C         THIS SUBROUTINE RETURNS DIMENSIONLESS VALUES FOR THE EXTENT OF
C         VOLUMEN OF LOQUID REMAINING
C         VOLUME OF LIQUID,TIME FOR COMLETE EVAPORATION ETC., FOR THE SPR
C         CRYOGENIC LIQUID ON WATER.
C
C**************INPUT PARAMETERS*****************
C  ***    I     = A FLAG WHICH INDICATES WHAT KIND OF SPREAD THE LIQUID IS
C                 GOING (I =1 FOR ONE DIMENSIONAL SPREAD WITH CONSTANT HEA
C                 2 FOR ONE-DIM SPREAD WITH ICE FORMATION, 3 FOR RADIAL SP
C                 WITH CONSTANT HEAT FLUX, AND 4 FOR RADIAL SPREAD WITH IC
C                 TION.)
C  ***    TOW   = DIMENSIONALESS TIME AT WHICH THE VARIOUS QUANTITIES ARE
C  ***    DEL   = A QUANTITY THAT IS RELATED TO THE HEAT FLUX
C
C**************OUTPUT PARAMETERS*****************
C  ***    KHI   = DIMENSIONLESS EXTENT OF SPREAD
C  ***    K     = DIMENSIONLESS VOLUME OF THE LIQUID
C  ***    ETA   = DIMENSIONLESS THICKNESS OF THE LIQUID FILM DURING SPREAD
C  ***    TOWEN= DIMENSIONLESS TIME FOR COMOLETE EVAPORATION IF THE SPREA
C                 CONTINUES IN THE GRAVITY INERTIA REGIME ONLY.
C  ***    KHIMX= MAXIMUM EXTENT OF SPREAD(DIMENSIONLESS) IF THE SPREAD CO
C                 IN THE GRAVITY-INERTIA REGIME ONLY.
C
C***********************************************************************
C
      REAL K,KHI,KHIMX
      PI=3.14159265
      GO TO (10,20,30,40),I
C **      ONE DIMENSIONAL SPREAD WITH CONSTANT HEAT FLUX ***
10    KHI=1.39*TOW**(2./3.)+0.0966*DEL*TOW**(7./3.)
      K=1.-0.834*TOW**(5./3.)*DEL-0.029*(TOW**(10./3.))*DEL**2
      ETA=K/KHI
      KHIMX=1.5874/(DEL**.4)
      TOWEN=1.0891/(DEL**.6)
      RETURN
C  ***    ONE DIMENSIONAL SPREAD WITH ICE FORMATION ***
20    KHI=1.39*TOW**(2./3.)
      K=1.-1.19*DEL*TOW**(7./6.)
      ETA=K/KHI
      TOWEN=0.859/(DEL**(6./7.))
      KHIMX=1.39*(TOWEN**(2./3.))
      RETURN
C  ***    RADIAL SPREAD WITH CONSTANT HEAT TRANSFER RATE ***
30    KHI=SQRT(1.3*TOW+0.442*DEL*TOW**3)
      K=1.-2.04*DEL*TOW**2-0.347*(DEL**2)*(TOW**4)
      ETA=K/(PI*KHI**2)
      TOWEN=0.6743/SQRT(DEL)
      KHIMX=1.0059/(DEL**0.25)
      RETURN
C  ***    RADIAL SPREAD WITH ICE FORMATION ***
40    KHI=SQRT(1.415*DEL*TOW**2.5+1.3*TOW)
      K=1.-0.867*DEL*TOW**1.5-0.4716*(DEL**2)*(TOW**3)
      ETA=K/(PI*KHI**2)
      TOWEN=0.864/(DEL**(2./3.))
      KHIMX=1.451/(DEL**(1./3.))
      RETURN
      END
      OVERLAY(7,0)
      PROGRAM OV7
C
C         OV7 EXECUTES THE FOLLOWING GROUP OF RATE MODELS -
C
C                   RATE MODEL  =  F    INDEX  =  6
C                                  M             13
```

```
C                                        O              15
C                                        Y              25
C                                        Z              26
C                                       II              27
C                                       RR              28
C                                       SS              29
C
C         COMMON VARIABLES USED - MODNO
C
C         SUBROUTINES REQUIRED  - MODF,MODM,MODO,MODY,MODZ,MODII,MODRR,
C                                 MODSS,TRACE
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                              35/309A ACORN PARK,
C                              CAMBRIDGE, MASS., 02140
C                              TEL. 617-864-5770  EXT. 2813
C         DATE   - 8 JANUARY 1976
C
C
      COMMON/OVCNT/MODNO,OVLST(29),SGLST(29)
      INTEGER       OVLST,SGLST
C
C
C---------PRINT OVERLAY EXECUTION TRACE MESSAGE, THEN BRANCH ON MODEL
C         INDEX NUMBER
      CALL TRACE(0,7,0)
C
C---------SELECT MODEL F
      IF(MODNO.NE.6) GO TO 10
      CALL MODF
      GO TO 100
C
C---------SELECT MODEL M
   10 IF(MODNO.NE.13) GO TO 20
      CALL MODM
      GO TO 100
C
C---------SELECT MODEL O
   20 IF(MODNO.NE.15) GO TO 30
      CALL MODO
      GO TO 100
C
C---------SELECT MODEL Y
   30 IF(MODNO.NE.25) GO TO 40
      CALL MODY
      GO TO 100
C
C---------SELECT MODEL Z
   40 IF(MODNO.NE.26) GO TO 50
      CALL MODZ
      GO TO 100
C
C---------SELECT MODEL II
   50 IF(MODNO.NE.27) GO TO 60
      CALL MODII
      GO TO 100
C
C---------SELECT MODEL RR
   60 IF(MODNO.NE.28) GO TO 70
      CALL MODRR
      GO TO 100
C
C---------SELECT MODEL SS
   70 IF(MODNO.NE.29) GO TO 100
      CALL MODSS
C
C---------PRINT OVERLAY EXECUTION TRACE MESSAGE, THEN RETURN TO MAIN
C         HACS CONTROL
  100 CALL TRACE(1,7,0)
C
      END
      SUBROUTINE MODF
```

```
      CALL PAGER(2)
      WRITE(6,100)
      RETURN
  100 FORMAT(57H MODEL F HAS BEEN FUNCTIONALLY INCORPORATED INTO MODEL D
     1./)
      END
      SUBROUTINE MODII
C
      CALL PAGER(2)
      WRITE(6,100)
      RETURN
  100 FORMAT(45H MODEL FOR INSOLUBLE SOLIDS IS NOT AVAILABLE./)
      END
      SUBROUTINE MODM
      DATA MOD/4H  M /
    1 CONTINUE
      LP=6
      IR=0
      IS=6
      CALL BEGPR(MOD)
      CALL IRCL(2084,IFLAG,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
      CALL OUTPR(MOD)
      CALL PAGER(4)
      WRITE(LP,100)
      CALL ISV(2061,0,2)
      IF(IFLAG.EQ.1) GO TO 20
      CALL PAGER(4)
      WRITE(LP,200)
   20 CALL ENDPR(MOD)
   99 RETURN
100   FORMAT(66H MODEL FOR EVAPORATION RATE OF SOLUBLE LIQUIDS WHOSE BOI
     1LING POINT/39H IS LESS THAN AMBIENT IS NOT AVAILABLE./51H IN ORDER
     2 TO ASSESS THE VAPOR HAZARD WE ASSUME THAT/40H ALL THE GAS IS EVOL
     3VED INSTANTANEOUSLY./)
  200 FORMAT(/56H MODEL K HAS ALREADY ESTIMATED THE AMOUNT OF VAPOR WHIC
     1H/42H EVOLVES.  THIS AMOUNT IS USED IN MODEL N./)
      END
      SUBROUTINE MODO
      CALL PAGER(7)
      WRITE(6,100)
      RETURN
  100 FORMAT(58H MODEL FOR HEAT RELEASE FROM LIQUIDS THAT REACT WITH WAT
     1ER/18H IS NOT AVAILABLE./55H CONSULT MANUAL 2 TO DETERMINE THE PRO
     2DUCTS OF REACTION/27H OF THE CHEMICAL AND WATER./62H HAZARDS MAY B
     3E ESTIMATED SEPARATELY IF THE PRODUCTS HAVE BEEN/33H INCLUDED ON T
     4HE PROPERTIES FILE./)
      END
      SUBROUTINE MODRR
C
      CALL PAGER(2)
      WRITE(6,100)
      RETURN
  100 FORMAT(44H MODEL FOR REACTIVE SOLIDS IS NOT AVAILABLE./)
      END
      SUBROUTINE MODSS
C
      CALL PAGER(2)
      WRITE(6,100)
      RETURN
  100 FORMAT(45H MODEL FOR INSOLUBLE SOLIDS IS NOT AVAILABLE./)
      END
      SUBROUTINE MODY
C
      CALL PAGER(2)
      WRITE(6,100)
      RETURN
  100 FORMAT(24H MODEL Y DOES NOT EXIST./)
      END
      SUBROUTINE MODZ
```

```
C
      CALL PAGER(2)
      WRITE(6,100)
      RETURN
  100 FORMAT(53H MODEL FOR SELF REACTING SUBSTANCES IS NOT AVAILABLE./)
      END
      OVERLAY(10,0)
      PROGRAM OV8
C
C        PROGRAM OV8 EXECUTES THE FOLLOWING GROUP OF RATE MODELS -
C
C                    RATE MODEL  =       INDEX  =
C                                 I              9
C                                 K             11
C                                 P             16
C                                 R             18
C                                 T             20
C                                 V             22
C                                 X             24
C
C        COMMON VARIABLES USED - MODNO
C
C        SUBROUTINES REQUIRED  - MODK,MODP,MODR,MODT,MODV,TRACE .
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/309A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 8 JANUARY 1976
C
C
      COMMON/OVER/NOV,SEG
      COMMON/OVCNT/MODNO,OVLST(29),SGLST(29)
      INTEGER      OVLST,SGLST
C
C
C--------PRINT OVERLAY EXECUTION TRACE MESSAGE, THEN BRANCH ON MODEL
C        INDEX NUMBER
      CALL TRACE(0,8,0)
C
C--------SELECT MODEL I
      IF(MODNO.NE.9) GO TO 10
      SEG=1
      CALL SEGLOD(1)
      GO TO 100
C
C--------SELECT MODEL K
   10 IF(MODNO.NE.11) GO TO 20
      SEG=2
      CALL SEGLOD(2)
      GO TO 100
C
C--------SELECT MODEL P
   20 IF(MODNO.NE.16) GO TO 30
      SEG=2
      CALL SEGLOD(2)
      GO TO 100
C
C--------SELECT MODEL R
   30 IF(MODNO.NE.18) GO TO 40
      SEG=3
      CALL SEGLOD(3)
      GO TO 100
C
C--------SELECT MODEL T
   40 IF(MODNO.NE.20) GO TO 50
      SEG=4
      CALL SEGLOD(4)
      GO TO 100
C
C--------SELECT MODEL V
   50 IF(MODNO.NE.22) GO TO 60
```

```
      SEG=5
      CALL SEGLOD(5)
      GO TO 100
C
C--------SELECT MODEL X
   60 IF(MODNO.NE.24) GO TO 100
      SEG=6
      CALL SEGLOD(6)
C
C--------PRINT OVERLAY EXECUTION TRACE MESSAGE, THEN RETURN TO MAIN
C        HACS CONTROL
  100 CALL TRACE(1,8,0)
C
      END
      SUBROUTINE CDIFW(AM,DENL,TWAT,TCRIT,TBOIL,DIFCO)
C   **********************************************************************
C
C     THIS SUBROUTINE ESTIMATES THE DIFFUSION COEFFICIENT FOR A LIQUID
C     CHEMICAL IN WATER
C
C    *** INPUTS ***
C
C       AM      MOLECULAR WEIGHT OF CHEMICAL                      GM/MOLE
C     DENL      DENSITY OF CHEMICAL AT ITS BOILING POINT    GM/CM3
C     TWAT      TEMPERATURE OF WATER                             DEG. C
C     TCRIT     CRITICAL TEMPERATURE OF CHEMICAL                 DEG. C
C     TBOIL     BOILING TEMPERATURE OF CHEMICAL                  DEG. C
C
C   *** OUTPUTS ***
C
C     DIFCO     DIFFUSION COEFFICIENT OF CHEMICAL IN WATER      CM2/SEC
C
C    *********************************************************************
C
      TR=(TWAT+273.2)/(TCRIT+273.2)
      TBR=(TBOIL+273.2)/(TCRIT+273.2)
C
C     MOLAL VOLUME (VB) CALCULATION IS MATHIAS METHOD FOUND ON PG 106
C     OF 2ND ED. OF REID AND SHERWOOD, THE PROPS OF GASES AND LIQUIDS
C
      VB=(AM/DENL)*((2.-TR)/(2.-TBR))
C
C     VISCOSITY OF WATER EQUATION IS FROM PAGE 374 OF THE THIRD EDITION
C     OF PERRY'S CHEMICAL ENGINEERING HANDBOOK
C
      VISW=(2.1482*((TWAT-8.435)+SQRT(8078.4+((TWAT-8.435)**2.))))-120.
      VISW=100./VISW
C
C     DIFFUSION COEFFICIENT EQUATION IS WILKE AND CHANG METHOD FOUND
C     IN REID AND SHERWOOD ON PG 549.
C
      DIFCO=5.06E-07*(TWAT+273.2)/((VISW**1.1)*(VB**0.6))
      RETURN
      END
      SUBROUTINE COMPD(AM,TA,DENLB,DIFCO)
C     THIS SUBROUTINE CALCULATES THE DIFFUSION COEFFICIENT OF A VAPOR IN
C     AND SHOULD BE THE DEFAULT VALUE IF THE DATA IS NOT PRESENT IN THE
C     MANUAL 2 DATA FILE.
C
C  ***INPUTS
C
C     AM      THE MOLECULAR WEIGHT OF THE CHEMICAL
C     TA      AMBIENT TEMPERATURE,DEGREES C
C     DENLB   THE DENSITY OF THE LIQUID AT ITS BOILING POINT,GM/CM**3.
C
C  ***OUTPUTS
C
C     DIFCO   THE DIFFUSION COEFFICIENT,CM**2./SEC
C
      VB=29.9**.33333
      WMO=29.0
      VA=AM/DENLB
```

```
      T=(TA+273.2)**1.5
      S1=((1./WMO)+(1./AM))**.50
      S2=((VA**.33333)+VB)**2.
      DIFCO=.0043*(T/S2)*S1
      RETURN
      END
      SUBROUTINE CRITD(AVP,BVP,CVP,TEMP,DEPTH)
C
C   ****************************************************************
C
C       THIS SUBROUTINE CALCULATES THE DEPTH IN WATER AT WHICH A LIQUID
C      WITH A BOILING POINT LESS-THAN-AMBIENT TEMPERATURE WILL NOT BOIL
C      BECAUSE OF THE HYDROSTATIC PRESSURE ACTING UPON IT.  IT IS
C      PRIMARILY USEFUL FOR HEAVIER-THAN-WATER CHEMICALS SINCE LIGHTER
C      SUBSTANCES WILL RISE UNTIL THEY REACH A DEPTH AT WHICH THEY CAN
C      BOIL.
C
C  *** INPUTS ***
C
C      AVP      COEFFICIENT OF VAPOR PRESSURE EQUATION WHICH
C               GIVES ANSWER IN MM HG.
C      BVP       - - - - - - - - - - - - - - - - - - - - - - - -
C      CVP       - - - - - - - - - - - - - - - - - - - - - - - - - - -
C      TEMP     TEMPERATURE OF CHEMICAL                         DEG. C
C
C   *** OUTPUTS ***
C
C      DEPTH    DEPTH AT WHICH CHEMICAL WILL NOT BOIL           CMS
C
C   ****************************************************************
      GRAV=980.7
      DENL=1.0
      VAP=1333.224*10.**(AVP-(BVP/(TEMP+CVP)))
      PATM=760.*1333.224
      IF(VAP.LE.PATM) DEPTH=0.0
      IF(VAP.LE.PATM) GO TO 99
      DEPTH=(VAP-PATM)/(DENL*GRAV)
   99 RETURN
      END
      SUBROUTINE DISP(W,D,IFLAG,T,UF,UT,XN,TP,E,EX,EY,EZ)
C ******************************************************************
C ****  THIS SUBROUTINE IS CALLED BY THE DILUN SUBROUTINE , DISPERSION
C        AND TURBULENT DIFFUSION COEFFICIENTS ARE RETURNED BY THIS SUBROU
C
      PI=3.14159265
      B=W/2.
      IF(IFLAG.EQ.1) GO TO 60
      RH=W*D/(2.*D+W)
      GO TO (60,70,80),IFLAG
60    E=0.
      RETURN
C *** SPILL INTO A NON TIDAL RIVER
70    USTAR=6.7305*XN*UF/RH**(1./6.)
      EZ=0.067*USTAR*RH
      EX=0.1*EZ
      IF(W/D-100.) 72,71,71
71    EY=0.1*EZ
      E=136.09*XN*UF*RH**(5./6.)
      GO TO 75
72    EY=0.23*USTAR*RH
      E=225.*USTAR*RH
75    RETURN
C ***  TIDAL RIVER   ******
80    USTAR=6.7305*XN*(2.*UT/PI)/RH**(1./6.)
C  ***  USTAR IS BASED ON THE MEAN OSCILLATING FLOW VELOCITY.  ***
      EZ=0.067*USTAR*RH
      EX=0.1*EZ
      EY=0.1*EZ
      IF(W/D-100.) 81,82,82
81    EY=0.23*USTAR*RH
C  ** TRANSVERSE AND VERTICAL DISPERSION COEFFICIENTS
82    EV=6.*D*USTAR
```

```
      ET=0.011*0.025*EV*(UT*TP/B)**2
      TPV=TP/(D**2/EZ)
      TPT=TP/(B**2/EY)
      IF(TPV-1.) 83,83,84
83    GO TO 85
84    IF(ET/EV-1.) 85,85,86
85    E=EV
      GO TO 87
86    E=ET
87    RETURN
      END
      FUNCTION ERF(X)
      DIMENSION A(5)
      DATA P/0.3275911/,
     1     A(1)/0.254829592/,A(2)/-0.284496736/,A(3)/1.421413741/,
     2     A(4)/-1.453152027/,A(5)/1.061405429/
C   ...................................................................
C
C     ERF COMPUTES THE ERROR FUNCTION OF X BY SERIES EXPANSION WITH AN
C      ERROR LESS THAN OR EQUAL TO 1.5*10-7.
C     REFERENCE..        C. HASTINGS JR.
C                        APPROXIAMATIONS FOR DIGITAL COMPUTERS
C                        PRINCETON UNIVERSITY PRESS
C                        PRINCETON N.J. 1955
C
C
C   ...................................................................
C        CODE REVISIONS INSERTED 3 NOV 1978 BY R.G. POTTS
C        INCLUDES LIMIT TEST FOR ASYMPTOTIC VALUE
      ONE=1.0
      IF(X.LT.0.0) ONE=-ONE
      T=ONE/(ONE+P*X)
      EX=EXP(-X*X)
      ERF=1.0-(T*(A(1)+T*(A(2)+T*(A(3)+T*(A(4)+T*A(5)))))*EX)
      IF(ABS(1.0-ERF).LT.1.5E-7) ERF=1.0
      ERF=ONE*ERF
      RETURN
      END
      SUBROUTINE HMTC(DIFCO,XMOL,VOLI,HMP)
C
      ANU=0.15
      AL=VOLI**0.3333
      CUT=5.*10.**5
      TEMP= 293.
      RVAP=82.057/XMOL
      SCHM=ANU/DIFCO
      VELOC= 450.
      REYN=(VELOC*AL)/ANU
      IF(REYN-CUT) 1,1,2
    1 HBAR=(1.328*(REYN**.5)*DIFCO*(SCHM**.3333))/AL
      GO TO 3
    2 HBAR=(.037*DIFCO*(SCHM**.3333)*(REYN**0.8))/AL
    3 HMP=HBAR/(RVAP*TEMP)
      RETURN
      END
      SUBROUTINE RLJSP(IDIM,VOL,DENL,VISL,SURT,TIME,CHNLW,SIZE)
C
C     THIS SUBROUTINE CALCULATES THE SPREAD OF LIQUIDS ON WATER
C
C *** INPUTS
C
C     IDIM    DIMENSION OF SPILL (1 IF ONE DIMENSIONAL, 2 IF RADIAL)
C     VOL     QUANTITY OF SPILL                                 CM**3
C     DENL    DENSITY OF LIQUID                                 GM/CM**3
C     VISL    VISCOSITY OF LIQUID                               GM/CM-SEC
C     SURT    SURFACE TENSION WITH SEA WATER                    DYNES/CM
C     TIME    TIME                                              SEC
C     CHNLW   CHANNEL WIDTH (REQUIRED FOR IDIM=1 ONLY)          CM
C
C *** OUTPUTS
C
C     SIZE    SIZE OF SPILL AFTER TIME HAS ELAPSED (RADIUS OR LENGTH)-CM
C
```

```
      DATA GR,DENW,VISW/980.,1.,.01/
C.....CALCULATE NON-DIMENSIONAL PARAMETERS
      GO TO (5,10),IDIM
5     AL=SQRT(.5*VOL/CHNLW)
      GO TO 15
10    AL=VOL**.333333
15    G=GR*ABS(DENL-DENW)/DENW
      T=TIME/SQRT(AL/G)
      IF(VISW*.2 - VISL) 25,25,85
C.....START CALCULATIONS FOR THE CASE WHEN THE LIQUID VISOSITY IS
C.....GREATER THAN THE VISCOSITY OF WATER
25    A=(AL**3*G)**.25/SQRT(VISW/DENW)
      B=SURT/(VISW*SQRT(AL*G))
      GO TO (35,60),IDIM
C.....FOR THE ONE DIMENSIONAL CASE
35    IF(T-A**(6./7.))40,40,45
40    S=1.39*T**.666666
      GO TO 140
45    IF(T-(.972*A**.75/SQRT(B))**2.66666)50,50,55
50    S=1.39*A**.25*T**.375
      GO TO 140
55    S=1.43*SQRT(B/A)*T**.75
      GO TO 140
C.....FOR RADIAL SPREADING
60    IF(T-(.86*A**.166666)**4)65,65,70
65    S=1.14*SQRT(T)
      GO TO 140
70    IF(T-(.61*A**.666666)**2/B)75,75,80
75    S=.98*A**.166666*T**.25
      GO TO 140
80    S=1.6*SQRT(B/A)*T**.75
      GO TO 140
C.....START CALCULATIONS FOR THE CASE WHEN THE LIQUID VISCOSITY IS LESS
C.....THAN THE VISCOSITY OF WATER
85    A=(AL**3*G)**.25/SQRT(VISL/DENL)
      B=SURT/(VISL*SQRT(AL*G))
      GO TO (90,115),IDIM
C.....FOR THE ONE DIMENSIONAL CASE
90    IF(T-(.81*A**.4)**(15./7.))40,40,100
100   IF(T-(.90*A**.4/B**.333333)**7.5)105,105,110
105   S=1.13*A**.4*T**.2
      GO TO 140
110   S=1.26*(B*T)**.333333
      GO TO 140
C.....FOR RADIAL SPREADING
115   IF(T-(.685*A**.25)**2.66666)65,65,125
125   IF(T-(.735*(A/B)**.25)**8)130,130,135
130   S=.78*A**.25*T**.125
      GO TO 140
135   S=1.062*(B*T)**.25
C.....CALCULATE SIZE AND RETURN
140   SIZE=S*AL*FLOAT(3-IDIM)
      RETURN
      END
      SUBROUTINE SOLUB(TEMP,CSAT,IS,IR)
C   ********************************************************************
C
C     THIS SUBROUTINE INTERROGATES THE STATE FILE TO DETERMINE THE
C     AVAILABILITY OF CHEMICAL SOLUBILITY DATA.  IF THE COEFFICIENTS
C     FOR THE SOLUBILITY AS A FUNCTION OF TEMPERATURE EQUATION ARE
C     PRESENT, IT UTILIZES THEM TO CALCULATE THE SOLUBILITY AT THE
C     SPECIFIED TEMPERATURE.  IF THEY ARE NOT PRESENT, IT RETURNS THE
C     SOLUBILITY AT A FIXED TEMPERATURE WHICH MIGHT ALTERNATIVELY BE
C     STORED IN THE DATA BASE.
C
C   *** INPUTS ***
C
C       TEMP   TEMPERATURE AT WHICH SOLUBILITY DESIRED          DEG C
C
C   *** OUTPUTS ***
C
C     CSAT     SOLUBILITY OF CHEMICAL       GM SOLUTE/ 100 GMS SOLVENT
```

```
C      IR      CODE FOR CONFIRMING VALIDITY OF DATA RECALLED FROM
C              SUBROUTINE FRCL
C      IS      SOURCE CODE OF OUTPUT OF FRCL
C
C    *****************************************************************
      IND=0
      ISAVS=IS
      ISAVR=IR
      IS1=8
      IER1=0
      CALL FRCL(1028,SOL1,IS1,IER1)
      IF(IER1.EQ.1) IR=1
      IF(IS1.LT.IS) IS=IS1
      IS2=8
      IER2=0
      CALL FRCL(1029,SOL2,IS2,IER2)
      IF(IER2.EQ.1) IR=1
      IF(IS2.LT.IS) IS=IS2
      IF(IS1.GT.1.AND.IS2.GT.1) CSAT=SOL1+(SOL2*(TEMP+273.16))
      IF(IS1.GT.1.AND.IS2.GT.1) RETURN
      CALL PAGER(4)
      WRITE(6,10)
      IF(IER1.EQ.1.OR.IER2.EQ.1) IND=1
      IF(IND.EQ.1.AND.ISAVR.EQ.0) IR=0
      IF(IS1.LT.ISAVS.OR.IS2.LT.ISAVS) IS=ISAVS
      IS3=8
      IER=0
      CALL FRCL(1026,CSAT,IS3,IER3)
      IF(IER3.EQ.1) IR=1
      IF(IS3.LT.IS) IS=IS3
      RETURN
   10 FORMAT(/1X,62HTHE SOLUBILITY EQUATION COEFFICIENTS ARE NOT IN THE
     *DATA BASE./,1X,51HTHE SOLUBILITY AT A FIXED TEMP IS THEREFORE CALL
     *ED./)
      END
      OVERLAY(10,1)
      PROGRAM MODI
C
C
C        PROGRAM EXECUTES MODEL I, INDEX 9
C
C
C         MODI OBTAINS THE NECESSARY DATA FOR EXECUTION OF SUBROUTINE
C         EVDRP, WHICH CALCULATES THE RATE OF EVAPORATION THAT IS
C         SPILLED ON THE WATER SURFACE
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      DIMENSION AT(20),AV(20),AEV(20),ASAV(20)
      DIMENSION PTITL(6),PTIT(6),XTITL(6),XTITL1(6),YTITL(6),YTITL1(6)
      EQUIVALENCE (XBX(1),AT(1)),(XBX(41),AEV(1)),(XBX(21),AV(1))
      EQUIVALENCE (XBX(61),ASAV(1))
      DATA MOD/4H  I /
     0DATA (PTITL (I),I=1,6)/8HVOLUME O,8HF LIQUID,8H REMAINI,
     18HNG VS TI,8HME - MOD,8HEL I     /
     0DATA (PTIT  (I),I=1,6)/8HEVAPORAT,8HION RATE,8H VS TIME,
     18H - MODEL,2H I,1H /
     0DATA (XTITL (I),I=1,6)/8HELAPSED ,8HTIME....,8H........,
     18H........,8H.......(,8HSECONDS)/
     0DATA (XTITL1(I),I=1,6)/8HELAPSED ,8HTIME....,8H........,
     18H........,8H.......(,8HMINUTES)/
     0DATA (YTITL (I),I=1,6)/8HVOLUME  ,8H        ,8HREMAININ,
     18HG       ,8H(M**3)  ,1H /
     0DATA (YTITL1(I),I=1,6)/8HEVAPORAT,8HION     ,8HRATE    ,
     18H        ,8H(KG/SEC),1H /
    1 CONTINUE
C
      CALL TRACE(0,8,1)
      LP=6
      IR=0
      IS=6
C
```

```
C        OBTAIN DATA
C
      CALL BEGPR(MOD)
      CALL FRCL(1003,TBOIL,IS,IR)
      CALL FRCL(1008,SURT,IS,IR)
      CALL FRCL(1010,AVP,IS,IR)
      CALL FRCL(1011,BVP,IS,IR)
      CALL FRCL(1012,CVP,IS,IR)
      CALL FRCL(1014,XLAT,IS,IR)
      CALL FRCL(1021,DENL,IS,IR)
      IF(DENL-1.0)20,20,30
   20 CALL PAGER(6)
      WRITE(LP,100)
      DENL=1.01
   30 CONTINUE
      CALL FRCL(2023,TINF,IS,IR)
      CALL FRCL(2036,TCRY,IS,IR)
      CALL FRCL(4002,TML,IS,IR)
      VI=TML/DENL
      CALL FRCL(4050,TIMEL,IS,IR)
      CALL IRCL(3007,IIPF,IS,IR)
      CALL IRCL(3016,ITAB,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
C
C         CALL EVDRP
      TIME=1000000.0
      CALL EVDRP(VI,DENL,SURT,XLAT,TINF,TCRY,TIME,V,TOTEV,TIMCR)
C
C     CALL CRITICAL DEPTH CALCULATION ROUTINE
C
      TMX=TINF
      IF(TCRY.GT.TMX) TMX=TCRY
C
C     THE GREATER OF THE WATER TEMPERATURE OR THE CARGO TEMPERATURE
C     IS USED IN THE CALCULATION
C
      CALL CRITD(AVP,BVP,CVP,TMX,DEPTH)
C
C         UPDATE STATE VECTOR
C
      CALL OUTPR(MOD)
      CALL FSV(4021,TIMCR,4)
      CALL FSV(4046,DEPTH,4)
      CALL ENDPR(MOD)
      CALL PAGER(3)
      WRITE(LP,46)
      CALL ISV(2018,2,4)
      CALL FSV(2019,150.,4)
      CALL FSV(4068,TBOIL,4)
      ISP=0
      TIMET=TIMCR+TIMEL
      IF(TIMET.LT.600.) GO TO 36
      FLOW=TML/TIMET
      ISP=1
      CALL FSV(4044,FLOW,4)
      CALL FSV(4045,TIMET,4)
   36 CALL ISV(2061,ISP,4)
C
C     INTERROGATE USER PLOT AND TABLE FLAGS
C
      IF(IIPF.EQ.0.AND.ITAB.EQ.0) GO TO 99
      DT=TIMCR/19.
C
C         SET UP LOOP TO CALCULATE PLOT ARRAYS OF TIME VERSUS EVAPORATIO
C
      DO 10 I=1,20
      AT(I) = FLOAT(I-1)*DT
      CALL EVDRP(VI,DENL,SURT,XLAT,TINF,TCRY,AT(I),AV(I),AEV(I),TIMCR)
   10 CONTINUE
      IF(IIPF.NE.1) GO TO 40
```

```
      DO 16 II=1,2
      DO 15 I=1,20
      IF(II.EQ.1) ASAV(I)=AV(I)/1000000.
   15 IF(II.EQ.2) ASAV(I)=AEV(I)/1000.
      DIV=60.
      IF(II.EQ.1) CALL PLTLP(PTITL,AT,ASAV,20,XTITL,YTITL,1,60.,XTITL1)
      IF(II.EQ.2) CALL PLTLP(PTIT,AT,ASAV,20,XTITL,YTITL1,1,60.,XTITL1)
   16 CONTINUE
C
C---------SET UP OFF-LINE PLOT
      PLTYP=6
C
   40 IF(ITAB.NE.1) GO TO 99
      CALL PAGER(0)
      CALL PAGER(8)
      WRITE(LP,41)
      WRITE(LP,42)
      WRITE(LP,43)
      DO 44 I=1,20
      RMKG=AV(I)*DENL/1000.
      EVRKG=AEV(I)/1000.
      EVRLB=AEV(I)/454.
      RMLB=AV(I)*DENL/454.
      CALL PAGER(1)
      WRITE(LP,45) AT(I),RMKG,RMLB,EVRKG,EVRLB
   44 CONTINUE
      GO TO 99
   41 FORMAT (//9X,62HTABLE OF MASS REMAINING AND EVAPORATION RATE VS TI
     1ME - MODEL I//)
   42 FORMAT(7X,4HTIME,9X,12HMASS REMAINS,5X,12HMASS REMAINS,7X,9HEVAP R
     1ATE,8X,9HEVAP RATE)
   43 FORMAT(6X,6H(SECS),12X,4H(KG),13X,4H(LB),12X,8H(KG/SEC),9X,8H(LB/S
     1EC)//)
   45 FORMAT(3X,G12.4,4(5X,G12.4))
   46 FORMAT(//1X,63HTHE FOLLOWING PARAMETERS ARE ESTIMATED IN CASE MODE
     1L J FOLLOWS-)
  100 FORMAT(/69H WARNING- THE CHEMICAL SPILLED HAS A LIQUID DENSITY SO
     *CLOSE TO WATER/,66H THAT IT MAY OR MAY NOT SINK. FOR MODEL I, IT W
     *ILL BE ASSUMED THAT/,35H IT HAS A DENSITY OF 1.01 GM/CM**3.//)
   99 CONTINUE
      CALL TRACE(1,8,1)
      END
      SUBROUTINE  EVDRP(VI,DENL,SURT, XLAT,TINF,TCRY,TIME,V,TOTEV,TIMCR)
C
C ***  THIS ROUTINE CALCULATES THE RATE OF EVAPORATION AND TIME TO
C ***  COMPLETELY EVAPORATE FOR A HEAVIER-THAN-WATER, INSOLUBLE
C ***  LIQUID WITH A BOILING POINT LESS THAN THE AMBIENT TEMPERATURE.
C ***            AT TIME=TIME
C
C   *******************************************************************
C
C ******************INPUT ARGUMENTS ******************
C ***  VI    = VOLUME OF THE SPILL OF THE LIQUID           CM**3
C ***  SURT  % SURFACE TENSION OF LIQUID                         DYNE/CM
C ***  XLAT  = LATENT HEAT OF VAPORISATION OF LIQUID       CAL/GM
C ***  TINF  = TEMPERATURE OF THE AMBIENT WATER            DEG C
C ***  TCRY  = TEMPERATURE OF THE LIQUID SPILLED           DEG C
C ***  TIME  = TIME(FROM THE INSTANT OF SPILL) AT WHICH          SECS
C              THE INFORMATION ABOUT EVAPORATION RATE IS TO BE KNOWN.
C ***  DENL = DENSITY OF LIQUID SPILLED                     GM/CM3
C ***************** OUTPUT ARGUMENTS ***********************
C ***  V     = VOLUME OF THE LIQUID LEFT IN THE SYSTEM      CM**3
C ***  TOTEV = TOTAL EVAPORATION RATE FROM THE LIQUID       GMS/SEC
C              AT TIME ISTANT =TIME.
C ***  TIMCR - TIME TO EVAPORATE ALL OF THE LIQUID          SECS
C
C ************************ OTHER PARAMETERS ******************************
C
C ***  WC    = CRITICAL WEBER NUMBER AT WHICH LIQUID
C              BREAKS UP (8)WC)10)
C ***  CD    = DRAG COEFFICIENT DURING THE DESCENT OF A
```

```
C                DROPLET IN WATER.
C ***  GEFF  = EFFECTIVE GRAVITY ((GR*(DENL/DENW-1.)))      CM/SEC**2
C ***  GR    = GRAVITATIONAL ACCELERATION                   CM/SEC**2
C ***  PRW   = PRANDTL NUMBER FOR WATER
C
      DATA DENW,VISW,CPW,PRW,WC,CD,GR /1.0,0.01,1.0,7.0,10.0,0.4,980./
      PI=3.141592654
      A=1.778
      DELRO=DENL-DENW
      GEFF=GR*(DENL/DENW-1.)
      DEL=0.056*WC
      F=SQRT((1.-DEL)*((1.+A*(1.-DEL)**1.5)/(1.+A)))
      RO=SQRT((3./8.)*(WC/F**2.)*CD*(SURT/(GR*DELRO)))
      UO=F*SQRT((8./3.)*(GEFF/CD)*RO)
      B=CPW*(TINF-TCRY)/XLAT
      G=DENW*UO
      REY=(UO*2.*RO)/(VISW/DENW)
      STANT=0.69*(1./REY**0.3)*(1./PRW**0.66667)
      CEVAP=G*STANT*ALOG(1.+B)
      EVAPO=(3./RO)*VI*CEVAP
      CT=DENL*RO/CEVAP
C ***  CEVAP  IS THE EVAPORATION RATE PER UNIT AREA AT ZERO TIME FROM A
C ***  CT     IS THE CHATACTERISTIC EVAPORATION TIME AS DEFINED
C ***  EVAPO IS THE TOTAL EVAPORATION RATE IN GMS/SEC AT ZERO TIME.
      TIMCR=CT/0.95
      IF(TIME-TIMCR) 10,20,20
10    TOW=TIME/CT
      ETA=(1.-0.95*TOW)**(1./0.95)
      TOTEV=EVAPO*ETA**2.05
      V=VI*ETA**3
      RETURN
20    V=0.
      TOTEV=0.0
      RETURN
      END
      OVERLAY(10,2)
      PROGRAM LINK1
C
C        PROGRAM LINK1 IS A MAIN PROGRAM FOR OVERLAY 8, SEGMENT 2
C        AND IS USED SIMPLY TO PASS CONTROL TO THE RATE MODELS K AND P.
C
      COMMON/OVCNT/MODNO,OVLST(29),SGLST(29)
      INTEGER OVLST,SGLST
C
      CALL TRACE(0,8,2)
      IF(MODNO.EQ.11) CALL MODK
      IF(MODNO.EQ.16) CALL MODP
      CALL TRACE(1,8,2)
      END
      SUBROUTINE BBLDIS(T,H,DIFCO,C,AM,FV,FM)
C
C*********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE RATE OF DISSOLUTION OF A
C     VAPOR BUBBLE IN WATER WHEN THE VAPOR IS RELEASED UNDER
C     WATER.  THE OUTPUT FROM THE ROUTINE IS THE FRACTION OF
C     INITIAL VOLUME OF THE BUBBLE THAT ESCAPE INTO THE ATMOSPHERE
C     FOR A GIVEN RELEASE DEPTH.
C
C     INPUTS
C
C     T     =  TEMPERATURE OF WATER.                          DEG.C
C     H     =  DEPTH OF RELEASE UNDER WATER                   CMS
C     DIFCO=   DIFFUSION COEFFICIENT OF GAS SPECIMEN
C              IN WATER.                                      CM**2/SEC
C     C     =  EQUILIBRIUM INTERFACIAL CONTENTRATION OF GAS
C              (EQUIVALENTLY IT IS THE SOLUBILITY OF GAS IN
C              WATER)                                         G-MOLES/CM**3
C     AM    =  MOLELCULAR WEIGHT OF THE GAS                   GM-MOLE/GM
C
C     OUTPUTS
C
```

```
C      FV    =  FRACTION OF THE INITIAL VOLUME OF THE GAS
C               EMERGING FROM THE SURFACE OF THE WATER BODY.
C      FM    =  FRACTION OF THE INITIAL MASS OF GAS
C               RELEASED UNDER WATER, EXCAPING INTO THE
C               ATMOSPHERE.
C
C      OTHER PARAMETERS
C
C      ALPHA=   A DRAG FACTOR GENERALLY EQUAL TO ABOUT 30.
C      KFP   =  TURBULENT FLUCTUATION VALUE FOR DRAG
C               DUE TO FLOW OF GAS INSIDE THE BUBBLE.
C               (ABOUT 30)
C      DENW  =  DENSITY OF WATER=1.0                         G/CM**3
C      GR    =  GRAVITATIONAL ACCELERATION=980.              CM/SEC**2
C      PA    =  ATMOSPHERIC PRESSURE=1.0133E6                DYNES/CM**2
C      NUW   =  KINEMATIC VISCOSITY OF WATER=1.0E-2          CM**2/SEC
C      RUNIV=   UNIVERSAL GAS CONSTANT=8.314E7               ERG/GMMOLDEGK
C      F     =  MASS TRANSFER COEFFICIENT FACTOR WHICH
C               TAKES INTO ACCOUNT THE FACT THAT THE
C               TRANSFER COEFFICIENT VALUE IS REDUCED DUE TO
C               THE EFFECT OF THE NEIGHBORING GAS BUBBLES.
C      RHOVI=   THE INITIAL MOLAR DENSITY OF THE VAPOR
C               AT THE POSITION OF RELEASE UNDER WATER.
C      RI    =  THE INITIAL RADIUS OF BUBBLE WHICH IS EQUAL
C               TO THE CRITICAL RADIUS FOR STABILITY.
C      NI    =  THE NUMBER OF MOLES OF GAS IN THE INITIAL
C               BUBBLE.
C      RE    =  THE INITIAL REYNOLDS NUMBER
C      SC    =  THE SCHMIDT NUMBER
C      SH    =  SHERWOOD NUMBER.
C      SURT  =  INTERFACIAL TENSION BETWEEN WATER AND GAS.   DYNES/CM
C      KLI   =  THE LIQUID SIDE MASS TRANSFER COEFFICIENT
C               INITIALLY                                    CM/SEC
C
C*********************************************************************
C
      REAL NUW,NI,KLI,KFP
      DATA  DENW,GR,PA,NUW,RUNIV,EPSILN,ALPHA,KFP/ 1.0,980.,1.0133E6,1.E
     1-2,8.314E7,0.5,0.08,0.5/
      SURT=70.0
      PI=3.141592654
      RHOW=DENW
      F=(1.5*(1.-EPSILN))**(1./3.)/EPSILN
C
C      CALCULATION OF DIMENSIONLESS PARAMETERS
C
      PSTAR=(RHOW*GR*H/PA)
      P=PA*(1.+PSTAR)
      DENV=P*AM/(RUNIV*(T+273.))
      U=((4./ALPHA)*(GR*SURT**2/(DENW**2*NUW))*(DENV/DENW))**0.2
      RI=((3./KFP)*(DENW/DENV))**(1./3.)*(SURT/(DENW*U*U))
      NI=((4./3.)*PI*RI**3)*(DENV/AM)
      SC=NUW/DIFCO
      AI=4.*PI*RI*RI
      RE =U*RI/NUW
      SH=0.6*(RE**0.5)*(SC**(1./3.))
      KLI=(SH*DIFCO/RI)*F
      USTAR=(U/H)*(NI/(KLI*AI*C))
      B=((1.+PSTAR)/(PSTAR*USTAR))
      PHI  =B+(1.-B)*SQRT(1.+PSTAR)
      IF(PHI.LT.0.0) PHI=0.0
      FV=PHI**2
      FM=FV/(1.+PSTAR)
      RETURN
      END
      FUNCTION CNSPL(IFLAG,X,Y,Z,T,W,D,UF,UT,TP,DEL,XK,E,TMT,ZMDOT,TOW)
C ***   THIS FUNCTION IS CALLED BY THE DLIN INTEGRATION SUBROUTINE .
C       THIS FUNCTION RETURNS THE VALUES OF THE INTEGRAND IN THE INTEGRAL
C       OBTAIN THE CONCENTRATION AT ANY POSITION AND TIME WHEN THE SPILL
C       CONTINUOUS.
      PI=3.14159265
      GO TO (10,20,30),IFLAG
```

```
C ***  CONTINUOUS SPILL IN STILL WATER
10     IF(T-TOW) 11,11,12
11     CNSPL=0.
       RETURN
12     F1=(2.*ZMDOT)/(4.*PI*E)**1.5
       F2=EXP(-((X**2+Y**2+Z**2) /(4.*E*(T-TOW)))-XK*(T-TOW)) /(T-TOW)**1
      1.5
       CNSPL=F1*F2
20     RETURN
C ***  TIDAL RIVER AND ESTURINE CONTINUOUS SPILL MODELS
30     IF(T-TOW) 31,31,32
31     CNSPL=0.
       RETURN
32     TT=T-TOW
       SIG=2.*PI/TP
       F1=ZMDOT/(W*D*SQRT(4.*PI*E))
       F2= ((X-UF*TT+(UT/SIG)*(COS(SIG*(T-DEL))-COS(SIG*(TOW-DEL))))/SQRT
      1(4.*E*TT))**2-XK**TT
       F3=EXP(-F2)/SQRT(TT)
       CNSPL=F1*F3
       RETURN
       END
       SUBROUTINE DILUN(IFLAG,ICOND,ZMAS,ZMDOT,X,Y,Z,TIME,DIFCO,D,W,A,UF,
      1UT,TP,DEL,XK,XN,C)
C
C *****************************************************************
C***   THIS SUBROUTINE GIVES THE CONENTRATION OF A WATER MISCIBLE LIQUID
C      SPECIFIED SPATIAL POINT AND GIVEN TIME, FOR SPILL IN LAKE, RIVER O
C      ESTUARY. ALL THE LIQUID SPILLED IS ASSUMED TO TO GO INTO SOLUTION
C      WATER. THE SAME PROGRAM CAN ALSO BE USED FOR DISPERSION OF SOLIDS
C      ARE NEUTRALLY BUOYANT OR WHOSE SETTLING TIMES ARE LARGE COMPARED T
C      TIMES.
C
C      THIS SUBROUTINE CANNOT BE USED WITH ACCURACY FOR CONCENTRATION PRE
C      FOR THOSE FLUIDS WHICH REACT WITH WATER OR WHOSE BOILING POINT IS
C      THAN THAT OF THE AMBIENT TEMPERATURE.
C *****************************************************************
C
C *********   INPUT ARGUMENTS    **********
C ***   IFLAG =   FLAG INDICATING WHERE THE SPILL OCCURS. (1 FOR SPILL IN
C                 STILL WATER ,2 FOR NON TIDAL RIVER, 3 FOR TIDAL REGIONS
C ***   ICOND =   A FLAG WHICH SPECIFIES WHETHER THE SPILL IS CONTINUOUS O
C                 OF SHORT DURATION(INSTANTANEOUS) SPILL. THE VALUE OF I
C                 0 FOR SHORT DURATION SPILL AND 1 FOR CONTINUOUS SPILL.
C ***   ZMAS  =   TOTAL MASS OF LIQUID SPILLED             GMS
C ***   ZMDOT =   RATE OF MASS SPILL (TO BE GIVEN ONLY IF ICOND=1)     GMS
C ***   X,Y,Z =   CO ORDINATE POSITIONS AT WHICH THE CONCENTRATION IS NEED
C                 THE ORIGIN IS ON THE WATER SURFACE . FOR RIVER SPILLS TH
C                 X-DIRECTION IS IN THE DIRECTION  OF FLOW AND Z- DIRECTIO
C                 DEPTHWISE.                                          CMS
C ***   TIME  =   TIME (COUNTED FROM INSTANT OF SPILL) AT WHICH THE CONCEN
C                 TION AT POINT X,Y,Z IS TO BE KNOWN.                  SE
C ***   DIFCO =   DIFFUSION COEFFICIENT FOR THE LIQUID IN WATER        CM*
C ***   D     =   MEAN RIVER DEPTH                                     CMS
C ***   W     =   MEAN RIVER WIDTH                                     CMS
C ***   A     =   Y-COORDINATE OF THE POINT OF SPILL ON THE WATER SURFACE
C ***   UF    =   STREAM VELOCITY  ( TO BE GIVEN IF IFLAG =2 OR 3)     CMS
C ***   UT    =   TIDAL VELOCITY AMPLITUDE  (FOR IFLAG = 3)            CMS
C ***   TP    =   TIDAL PERIOD                                         SEC
C ***   DEL   =   PHASE LAG-- ESSENTIALLY THE TIME FOR THE NEXT HIGH WATER
C                 SLACK FROM THE INSTANT OF SPILL.                     SEC
C ***   XK    =   DECAY COEFFICIENT ( TO BE GIVEN ONLY IF THE POLLUTANT DE
C                 AS PER THE FIRST ORDER DECAY EQUATION).              1./
C ***   XN    =   MANNING FACTOR OF ROUGHNESS FOR RIVERS           NON-DIM
C
C *************        OUTPUT ARGUMENTS      ************
C ***   C     =   CONCENTRATION OF THE POLLUTANT                       GMS
C *****************************************************************
C
C
       EXTERNAL CNSPL
       DIMENSION AUX(1)
```

```
      PI=3.14159265
      IJ=0
      ISAV=ICOND
      B=W/2.
      T=TIME
      IF(ICOND) 20,20,5
5     TMT=ZMAS/ZMDOT
C ***  TMT IS THE TIME TO EMPTY [ZMAS[ AT THE RATE OF [ZMDOT[.
      IF(IFLAG.EQ.2) GO TO 20
      IF(T-5.*TMT) 20,10,10
   10 IJ=1
      ICOND=0
20    CONTINUE
      IF(ICOND)50,50,100
50    CONTINUE
C ***  INSTANTANEOUS SPILL FORMULAE  *********
      GO TO (60,70,80),IFLAG
C ***   SPILL IN CALM AND STILL WATER   *********
60    C=((2.*ZMAS)/(4.*PI*T*DIFCO)**1.5)*EXP(-(X**2+Y**2+Z**2)/(4.*DIFCO
     1*T))*EXP(-XK*T)
      IF(IJ.EQ.1) ICOND=ISAV
      RETURN
C ********    SPILL INTO A NON TIDAL RIVER     ********
70    CALL DISP(W,D,IFLAG,T,UF,UT,XN,TP,E,EX ,EY,EZ)
      TC=B**2/EY
C *** NEAR FIELD APPROXIMATION ***
74    F1=(2.*ZMAS)/((4.*PI*T)**1.5*SQRT(EX*EY*EZ))
      F2=EXP(-(XK*T+(X-UF*T)**2/(4.*EX*T)))
      F3=EXP(-(Y-A)**2/(4.*EY*T))+EXP(-(Y+A+W)**2/(4.*EY*T))
     1+EXP(-(Y-W+A)**2/(4.*EY*T))
      F4=EXP(-(Z**2/(4.*EZ*T)))+EXP(-((Z-2.*D)**2/(4.*EZ*T)))
      F4=F4+EXP(-((Z+2.*D)**2/(4.*EZ*T)))
      C=F1*F2*F3*F4
      RETURN
C  *******      SPILL INTO TIDAL REGIONS OF A RIVER    *********
80    CALL DISP(W,D,IFLAG,T,UF,UT,XN,TP,E,EX ,EY,EZ)
      SIG=2.*PI/TP
C  ****     THE CROSS SECTIONAL MEAN CONCENTRATION IS CALCULATED ASSUMING
C           THE RIVER OSCILLATION VELOCITY TO BE SUNUSOIDAL.
      F1= ZMAS /(W*D*SQRT(4.*PI*E*T))
      F2=EXP(-XK*T)
      F31=X-(UF*T)
      F32=(UT/SIG)*(COS(SIG*(T-DEL))-COS(SIG*DEL))
      F33=(F31+F32)/SQRT(4.*E*T)
      F33=ABS(F33)
      IF(F33.GT.9.3) C=0.0
      IF(F33.GT.9.3) RETURN
      F3= ./EXP(F33*F33)
      C=F1*F2*F3
      IF(IJ.EQ.1) ICOND=ISAV
      RETURN
C
C *******     CONTINUOUS SPILLS  ****************
C **** IN THE FOLLOWING PROGRAM ON THE CONTINUOUS SPILLS WE ASSUME THAT
C  ****RATE OF SPILL [ZMDOT[ IS A CONSTANT.
10    GO TO (110,120,130),IFLAG
C  **  CONTINUOUS SPILL IN A STILL WATER REGION    *****
110   EPS=0.1
      NDIM=25
      IF(T-TMT) 112,112,113
112   CALL DLIN(IFLAG,X,Y,Z,T,UF,UT,TP,DEL,W,D,XK,DIFCO,TMT,ZMDOT,0.0,
     1T,EPS,NDIM,CNSPL,C,IER,AUX)
      RETURN
113   CALL DLIN(IFLAG,X,Y,Z,T,UF,UT,TP,DEL,W,D,XK,DIFCO,TMT,ZMDOT,0.0,
     1TMT,EPS,NDIM,CNSPL,C,IER,AUX)
      RETURN
C ***  SPILL IN A NON TIDAL RIVER  ***,  WE ASSUME THAT THE LONGITUDINAL
C      SION IS SMALL. THE CONCENTRATION GIVEN IS THE CROSS SECTIONAL AVE
120   C=0.
      IF(X-UF*T) 121,121,126
121   CALL DISP(W,D,IFLAG,T,UF,UT,XN,TP,E,EX ,EY,EZ)
      TC=B**2/EY
```

```
      XC=UF*TC
      IF(X-0.3*XC) 122,122,123
C  ****  NEAR FIELD APPROXIMATION
122   F1=ZMDOT/(2.*PI*X*SQRT(EY*EZ))
      TCN=X/UF
      F2=EXP(-((Y-A)**2/(4.*EY*TCN)))+EXP(-((Y+A+W)**2/(4.*EY*TCN)))
     1+EXP(-((Y-W+A)**2/(4.*EY*TCN)))
      F3=EXP(-(Z**2/(4.*EZ*TCN)))+EXP(-((Z-2.*D)**2/(4.*EZ*TCN)))
      F4=EXP(-(XK*TCN))
      C=F1*F2*F3*F4
      TSAV=(X/UF)+TMT
      IF(T.GT.TSAV) C=0.0
      RETURN
C ***  FAR FIELD APPROXIMATION   *********
  123 OMG=SQRT(UF**2+4.*XK*E)
      F1=ZMDOT/(W*D*OMG*2.)
      G1=1.
      G2=1.
      IF(T-TMT)125,125,124
124   G1=ERF((X+OMG*(T-TMT))/SQRT(4.*E*(T-TMT)))
      G2=ERF((X-OMG*(T-TMT))/SQRT(4.*E*(T-TMT)))
125   F2=(ERF((X+OMG*T)/SQRT(4.*E*T))-G1)*EXP((X*0.5/E)*(UF+OMG))
      F3=(ERF((X-OMG*T)/SQRT(4.*E*T))-G2)*EXP((X*0.5/E)*(UF-OMG))
      C=F1*(F2-F3)
126   RETURN
C ****    CONTINUOUS INJECTION IN TIDAL RIVERS  ********
130   CALL DISP(W,D,IFLAG,T,UF,UT,XN,TP,E,EX ,EY,EZ)
131   ESP=0.01
      NDIM=25
      IF(T-TMT) 132,132,133
132   CALL DLIN(IFLAG,X,Y,Z,T,UF,UT,TP,DEL,W,D,XK,E    ,TMT,ZMDOT,0.0,
     1T,EPS,NDIM,CNSPL,C,IER,AUX)
      RETURN
133   CALL DLIN(IFLAG,X,Y,Z,T,UF,UT,TP,DEL,W,D,XK,E    ,TMT,ZMDOT,0.0,
     1TMT,EPS,NDIM,CNSPL,C,IER,AUX)
      RETURN
      END
      SUBROUTINE DLIN(IFLAG,XX,YY,ZZ,T,UF,UT,TP,DEL,W,D,XK,S,TMT,ZMDOT,
     1XL,XU,EPS,NMAX,FCT,Y,IER,AUX)
C
C     THIS ROUTINE PERFORMS AN INTEGRATION OF A  CONCENTRATION EQUATION
C     WHICH GIVES THE CONCENTRATION AT SOME DOWNSTREAM LOCATION FOR
C     CONTINUOUS SPILLS OF A CHEMICAL INTO A TIDAL REGION.
C
C     THE CODING USED WAS TAKEN  ALMOST VERBATIM FROM A SAMPLE PROGRAM
C     GIVEN IN THE BOOK - APPLIED NUMERICAL METHODS - BY CARNAHAN,
C     LUTHER, AND WILKES PUBLISHED BY JOHN WILEY AND SONS, INC. SEE
C     THE SUBROUTINE NAMED TROMB ON PAGE 96.
C
      DIMENSION TA(20,20),AUX(1)
      NMAX=10
      IF(XU.GT.6000.) NMAX=11
C     NMAX IS AN INTEGER WHICH DEFINES THE ACCURACY OF THIS INTEGRATION.
C     IT WAS ARBITRARILY SET TO THE VALUES SHOWN TO PROVIDE A REASONABLE
C     DEGREE OF ACCURACY WHILE USING A REASONABLE AMOUNT OF COMPUTATION
C     TIME. THIS COMPROMISE CAN, HOWEVER, SOMETIMES RESULT IN CURVES
C     WHICH CONTAIN ONE OR MORE ERRATIC POINTS.
      JMAX=NMAX+1
      H=XU-XL
      TA(1,1)=0.5*H*(FCT(IFLAG,XX,YY,ZZ,T,W,D,UF,UT,TP,DEL,XK,S,TMT,
     1ZMDOT,XL)+FCT(IFLAG,XX,YY,ZZ,T,W,D,UF,UT,TP,DEL,XK,S,TMT,ZMDOT,XU)
     2)
      DO 2 N=1,NMAX
      TA(N+1,1)=0.0
      FR=H/2.0**N
      IMAX=2**N-1
      DO 1 I=1,IMAX,2
      TS=FLOAT(I)*FR+XL
    1 TA(N+1,1)=TA(N+1,1)+FCT(IFLAG,XX,YY,ZZ,T,W,D,UF,UT,TP,DEL,XK,S,
     1TMT,ZMDOT,TS)
    2 TA(N+1,1)=TA(N,1)/2.0+H*TA(N+1,1)/2.0**N
      DO 3 J=2,JMAX
```

```
      NXM=NMAX-J+2
      FORJ=4.0**(J-1)
      DO 3 N=1,NXM
    3 TA(N,J)=(FORJ*TA(N+1,J-1)-TA(N,J-1))/(FORJ-1.0)
      Y=TA(1,JMAX)
      RETURN
      END
      SUBROUTINE MODK
C
C     ******************************************************************
C            THE DECISION PROCESSES WITHIN SUBROUTINE MODK ARE EXCEEDINGLY
C      COMPLEX. A DETAILED DISCUSSION IS THEREFORE PRESENTED IN THE
C      FOLLOWING TO CLARIFY THE VARIOUS BRANCHINGS WHICH TAKE PLACE
C      DURING ITS EXECUTION.
C            MODEL K IS USED TO ASSESS THE HAZARDS OF SLIGHTLY SOLUBLE
C      CHEMICALS WHICH HAVE A BOILING POINT LESS THAN THE AMBIENT
C      TEMPERATURE. WHEN SUCH A SUBSTANCE IS OF FINITE SOLUBILITY AND IS
C      RELEASED UNDER WATER, SUBROUTINE BBLDIS IS USED TO DETERMINE
C      THE AMOUNT OF THE SUBSTANCE DISCHARGED WHICH GOES INTO SOLUTION
C      AND THE AMOUNT WHICH IS EVOLVED AS VAPOR FROM THE SURFACE OF THE
C      WATER.  THE PORTION WHICH GOES INTO SOLUTION IS THEN USED IN
C      MODEL P TO DETERMINE WATER POLLUTION HAZARDS.  THE AMOUNT
C      OF VAPOR IS TRANSFERRED TO MODELS M AND N, AND SUBSEQUENTLY TO
C      MODELS C1 AND C2, FOR THE DETERMINATION OF VAPOR DISPERSION
C      HAZARD EXTENTS.  SUBROUTINE BBLDIS IS APPROPRIATE FOR USE ONLY
C      IF THE CHEMICAL IS RELEASED AT A DEPTH GREATER THAN ABOUT TEN
C      FEET UNDER WATER AND IS SLIGHTLY OR MODERATELY SOLUBLE IN WATER9.
C      WHEN THE SUBSTANCE IS RELEASED ON OR NEAR THE SURFACE OF THE WATER
C      BODY AND/OR IS COMPLETELY MISCIBLE IN WATER,  BBLDIS CANNOT BE
C      USED.  IN THESE CASES, IT IS ASSUMED FOR THE PURPOSE OF EXECUTION
C      OF MODEL P, THE WATER DISPERSION MODEL, THAT ALL THE LIQUID GOES
C      INTO SOLUTION. THE AMOUNT OF VAPOR EVOLVED IS ESTIMATED IN MODEL
C      N, THE VAPOR DISPERSION MODEL.
C      THE DECISION PROCESS IS COMPLICATED BY TWO FACTORS. ONE OF THESE
C      CONCERNS THE PROPERTY FILE TAPE SINCE IT LISTS THE SOLUBILITY DATA
C      FOR A SUBSTANCE AS MISSING IF THE CHEMICAL IS COMPLETELY
C      MISCIBLE IN WATER.  THIS WAS DONE BECAUSE THE TRUE VALUE IS
C      INFINITY AND CANNOT BE PROPERLY REPRESENTED.  ITS CONSEQUENCE IS
C      THAT ACCESS TO THIS DATA DOES NOT ALLOW ACCURATE DETERMINATION OF
C      WHETHER THE SUBSTANCE IS COMPLETELY MISCIBLE OR IS OF UNKNOWN
C      FINITE SOLUBILITY.  TO ACCOUNT FOR THIS PREDICAMENT, THE MODEL
C      ASSUMES THE SUBSTANCE IS COMPLETELY MISCIBLE IN WATER AND
C      PROCEEDS AS DESCRIBED ABOVE.
C            THE OTHER PROBLEM ARISES FROM THE DENSITY OF THE SUBSTANCE.
C      IF THE DENSITY IS GREATER THAN WATER, THE SUBSTANCE IS RELEASED
C      ON OR NEAR THE BOTTOM OF THE WATERBODY, AND THE WATER DEPTH IS
C      SUCH THAT HYDROSTATIC PRESSURE DOES NOT ALLOW THE CHEMICAL TO
C      BOIL (CASE 1), VAPOR BUBBLES WILL NOT REACH THE SURFACE AND ALL
C      THE CHEMICAL WILL EVENTUALLY DISSOLVE.  THE DEPTH AT WHICH THE
C      LIQUID WILL NOT BOIL IS CALLED ITS CRITICAL DEPTH.  IF THE
C      SUBSTANCE IS DENSER THAN WATER AND IS RELEASED AT A DEPTH LESS
C      THAN ITS CRITICAL DEPTH IN A WATERBODY WHICH IS DEEPER THAN ITS
C      CRITICAL DEPTH ( CASE 2), SOME OF THE SUBSTANCE WILL BOIL OFF AND
C      FORM VAPOR BUBBLES WHICH HEAD TOWARDS THE SURFACE WHILE THE REST
C      SINKS TO A DEPTH AT WHICH IT CANNOT BOIL.  IF THE CHEMICAL IS LESS
C      DENSE THAN WATER AND IS RELEASED AT ANY POINT UNDER WATER (CASE 3)
C      IT WILL EITHER IMMEDIATELY BEGIN TO BOIL OR RISE UNTIL IT REACHES
C      A DEPTH AT WHICH IT CAN BOIL.
C            FOR CASE 1, MODEL K ASSUMES THAT ALL THE CHEMICAL INSTANTLY
C      DISSOLVES IN THE WATER AND EXECUTES MODEL P.  THE USERS MANUAL
C      NOTES THAT THE USER MAY WISH TO EXECUTE MODEL X FOR MORE ACCURATE
C      ANSWERS IF THE SUBSTANCE IS ONLY SLIGHTLY SOLUBLE.
C      FOR CASE 2,   IT  IS  ASUMED THAT  THE CHEMICAL  NEITHER  RISES
C      NOR  SINKS.   ALTHOUGH   THIS ASSUMPTION TENDS  TO
C      TO OVERESTIMATE THE AMOUNT OF VAPOR WHICH REACHES THE SURFACE AND
C      UNDERESTIMATE THE AMOUNT WHICH DISSOLVES, A BETTER PROCEDURE
C      COULD NOT BE ENVISIONED.
C            FOR CASE 3, IT IS ASSUMED THAT THE CHEMICAL IS RELEASED AT A
C      DEPTH JUST ABOVE ITS CRITICAL DEPTH.  THIS ALLOWS THE CHEMICAL TO
C      BOIL JUST AS IT WILL WHEN IT RISES TO THIS DISTANCE BENEATH THE
C      SURFACE.
C     ******************************************************************
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C
      DATA MOD/4H  K /
    1 CONTINUE
      LP=6
      IR=0
      IS=6
      C=0.1
C
C     OBTAIN NECESSARY DATA
C
      CALL BEGPR(MOD)
      CALL FRCL(2021,H,IS,IR)
      B=10.*12.*2.54
      IF(H.LT.B) GO TO 5
      CALL FRCL(1002,AM,IS,IR)
      CALL FRCL(1003,TB,IS,IR)
      CALL FRCL(1010,AVP,IS,IR)
      CALL FRCL(1011,BVP,IS,IR)
      CALL FRCL(1012,CVP,IS,IR)
      CALL FRCL(1021,DENL,IS,IR)
      CALL FRCL(1025,TC,IS,IR)
      CALL FRCL(2004,TEMP,IS,IR)
      CALL FRCL(2007,SPAMT,IS,IR)
      CALL FRCL(2023,T,IS,IR)
C
C     CALCULATE DIFFUSION COEFFIENT OF CHEMICAL IN WATER
C
      CALL PAGER(4)
      WRITE(LP,10)
      CALL CDIFW(AM,DENL,T,TC,TB,DIFCO)
      CALL FSV(2043,DIFCO,4)
      CALL FRCL(2043,DIFCO,IS,IR)
C
C     CALL ROUTINE SOLUB TO FIND SOLUBILITY OF CHEMICAL AT THE WATER
C     TEMPERATURE
C     SOLUB CALLS DATA OF FIELD NUMBERS 1026,1028, AND 1029.
      CALL SOLUB(T,CSAT,IS,IR)
      C=CSAT/(100.*AM)
      IF(C.NE.0.0) GO TO 5
      CALL PAGER(5)
      WRITE(LP,70)
      IF(C.EQ.0.0) GO TO 5
    5 CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
      IF(H.LT.B) GO TO 30
      IF(C.EQ.0.0) GO TO 31
      TMX=TEMP
      IF(T.GT.TMX) TMX=T
      CALL CRITD(AVP,BVP,CVP,TMX,DEPTH)
      CALL OUTPR(MOD)
      IF(DENL.GE.1.0) GO TO 6
      IF(H.LT.DEPTH) GO TO 6
      CALL PAGER(5)
      WRITE(LP,80)
    6 IF(DENL.LT.1.0.AND.H.GE.DEPTH) H=DEPTH
      IF(H.LT.B) GO TO 8
      CALL BBLDIS(T,H,DIFCO,C,AM,FV,FM)
      IF(DEPTH.LT.H) FM=0.0
      IF(FM.NE.0.0) GO TO 7
      CALL PAGER(4)
      WRITE(LP,20)
    7 AMTVP=FM*SPAMT
      CALL ISV(2029,0,4)
      CALL ISV(2084,0,4)
      CALL FSV(4001,AMTVP,4)
      AMTLQ=SPAMT-AMTVP
      CALL FSV(4002,AMTLQ,4)
      VOL=AMTLQ/DENL
      CALL FSV(4003,VOL,4)
      CALL FSV(4046,DEPTH,4)
      CALL FSV(4068,TB,4)
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      CALL PAGER(4)
      WRITE(LP,40)
      GO TO 50
    8 CALL PAGER(6)
      WRITE(LP,90)
      CALL ISV(2029,0,4)
      CALL ISV(2084,1,4)
      CALL FSV(4001,0.0,4)
      CALL FSV(4002,SPAMT,4)
      VOL=SPAMT/DENL
      CALL FSV(4003,VOL,4)
      CALL FSV(4046,DEPTH,4)
      CALL FSV(4068,TB,4)
      WRITE(LP,40)
      GO TO 50
   30 CALL PAGER(6)
      WRITE(LP,60)
   31 CALL PAGER(4)
      CALL ISV(2084,1,4)
      IF(C.EQ.0.0) CALL FSV(4001,0.0,4)
      IF(C.EQ.0.0) CALL FSV(4002,SPAMT,4)
      VOL=SPAMT/DENL
      IF(C.EQ.0.0) CALL FSV(4003,VOL,4)
      WRITE(LP,40)
   50 CALL MODP
      CALL ENDPR(MOD)
   99 RETURN
   10 FORMAT(/66H THE DIFFUSION COEFFICIENT OF THE CHEMICAL IN WATER IS
     1CALCULATED./)
   20 FORMAT(/64H THE CHEMICAL IS RELEASED AT TOO GREAT A DEPTH FOR VAPO
     1R BUBBLES/22H TO REACH THE SURFACE./)
   40 FORMAT(/53H MODEL P IS EXECUTED TO DETERMINE THE WATER POLLUTION/
     154H HAZARDS OF THE CHEMICAL WHICH DISSOLVES IN THE WATER./)
   60 FORMAT(/62H SINCE THE RELEASE IS ON OR NEAR THE SURFACE, AND A MOD
     1EL DOES/59H NOT EXIST WHICH ESTIMATES THE PROPORTION OF CHEMICAL W
     2HICH/61H DISSOLVES, IT IS ASSUMED THAT IT ALL DISSOLVES FOR EXECUT
     3ION/12H OF MODEL P./)
   70 FORMAT(/54H SUFFICIENT DATA DOES NOT EXIST TO ALLOW DETERMINATION/
     151H OF WHETHER THE CHEMICAL IS FULLY MISCIBLE IN WATER/54H OR OF F
     2INITE SOLUBILITY. IT IS THEREFORE ASSUMED THAT/35H ALL THE LIQUID
     3RELEASED DISSOLVES.)
   80 FORMAT(/58H SINCE THE CHEMICAL IS LESS DENSE THAN WATER AND WILL R
     1ISE/54H TO A DEPTH AT WHICH IT CAN BOIL, THE DEPTH OF RELEASE/38H
     3WAS CHANGED TO BE ITS CRITICAL DEPTH./)
   90 FORMAT(/65H SINCE THE CRITICAL DEPTH IS LESS THAN 10 FEET DEEP, TH
     1E SPECIFIC/69H AMOUNT OF CHEMICAL WHICH DISSOLVES IN THE WATER CAN
     2NOT BE ESTIMATED./67H IT IS THEREFORE ASSUMED THAT ALL LIQUID DISS
     3OLVES FOR EXECUTION OF/25H WATER POLLUTION MODEL P./)
      END
      SUBROUTINE MODP
C
C     SUBROUTINE MODP OBTAINS THE NECESSARY DATA FOR EXECUTION OF
C         SUBROUTINE DILUN, WHICH CALCULATES THE CONCENTRATION OF A
C         WATER-MISCIBLE LIQUID AT ANY SPECIFIED SPATIAL POINT AND
C         GIVEN TIME FOR A SPILL IN A LAKE, RIVER, OR ESTUARY.
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      LOGICAL YESNO
      DIMENSION ASAV(40),ASAVT(40)
      DIMENSION AT(40),AC(40),AXD(40),ATIM(40),ACONC(40,2)
      DIMENSION PTITL(6),XTITL(6),XTITL1(6),YTITL(6)
      EQUIVALENCE (XBX(61),X),(XBX(62),Y),(XBX(63),Z)
      EQUIVALENCE (XBX(66),UX),(XBX(67),TMINX),(XBX(68),ACONC(1,1))
      DATA MOD/4H  P /
     0DATA (PTITL (I),I=1,6)/8HCONCENTR,8HATION VS,8H TIME AT,
     18H A FIXED,8H POINT -,8H MODEL P/
     0DATA (XTITL (I),I=1,6)/8HELAPSED ,8HTIME FRO,8HM START ,
     18HOF SPILL,8H........,8HMINUTES)/
     0DATA (XTITL1(I),I=1,6)/8HELAPSED ,8HTIME FRO,8HM START ,
     18HOF SPILL,8H........,8H.(HOURS)/
     0DATA (YTITL (I),I=1,6)/8H   CONCE,8HNTRATION,8H    AT P,
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     18HOINT XYZ,1H ,5H(PPM)/
    4 CONTINUE
      IR=0
      IS=6
      LP=6
C
C          OBTAIN NECESSARY DATA
C
      CALL BEGPR(MOD)
      CALL IRCL(2028,IFLAG,IS,IR)
      CALL IRCL(2029,ICOND,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(1002,AM,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(1003,TBOIL,IS,IR)
      CALL FRCL(1004,DENL,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(1021,DENLB,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(1025,TCRIT,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(2023,TWAT,IS,IR)
      CALL FRCL(2039,X,IS,IR)
      CALL FRCL(2040,Y,IS,IR)
      CALL FRCL(2041,Z,IS,IR)
      CALL FRCL(2042,TIME,IS,IR)
      IF(IFLAG.NE.1) CALL FRCL(2044,D,IS,IR)
      IF(IFLAG.NE.1) CALL FRCL(2045,W,IS,IR)
      IF(IFLAG.NE.1) CALL FRCL(2046,A,IS,IR)
      IF(IFLAG.NE.1) CALL FRCL(2047,UF,IS,IR)
      IF(IFLAG.NE.3) GO TO 100
      CALL FRCL(2048,UT,IS,IR)
      CALL FRCL(2049,TP,IS,IR)
      CALL FRCL(2050,DEL,IS,IR)
  100 CONTINUE
      CALL FRCL(2051,XK,IS,IR)
      IF(IFLAG.NE.1) CALL FRCL(2052,XN,IS,IR)
      CALL FRCL(4002,ZMAS,IS,IR)
      IF(ICOND.EQ.1) CALL FRCL(4049,ZMDOT,IS,IR)
C
C    CALCULATE DIFFUSION COEFFICIENT OF CHEMICAL IN WATER.
C
      IF(IFLAG.NE.1) GO TO 30
      CALL PAGER(3)
      WRITE(6,40)
      CALL CDIFW(AM,DENLB,TWAT,TCRIT,TBOIL,DIFCO)
      DIFCO=DIFCO*1000.0
      CALL FSV(2043,DIFCO,4)
      CALL FRCL(2043,DIFCO,IS,IR)
   30 CONTINUE
      CALL IRCL(3008,IPPF,IS,IR)
      CALL IRCL(3015,ITAB,IS,IR)
      IF(ITAB.EQ.0.AND.IPPF.EQ.0) GO TO 1
      CALL FRCL(2037,TMXP,IS,IR)
    1 CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 4
C
C          CALL DILUN
      CALL DILUN(IFLAG,ICOND,ZMAS,ZMDOT,X,Y,Z,TIME,DIFCO,D,W,A,UF,
     1        UT,TP,DEL,XK,XN,CNTR)
C
C          UPDATE DATA BASE
C
      CALL OUTPR(MOD)
      IF(CNTR.GT.DENL) CNTR=DENL
      CALL FSV(4022,CNTR,4)
      CS=CNTR*1000000.0
      CPPM=CS/DENL
      CALL PAGER(2)
      WRITE(LP,31) CPPM,CS
      CALL ENDPR(MOD)
C
C     CALCULATE DATA OF CONCENTRATION VS TIME AT FIXED POINT
C     IF REQUESTED.
C
      ISTOP=0
```

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      IF(IPPF.EQ.0.AND.ITAB.EQ.0) GO TO 99
      IF(IPPF.EQ.2.AND.ITAB.EQ.2) GO TO 70
      IF (IFLAG.EQ.2) GO TO 25
      TMAXI=TMXP
      TMINI=60.
      GO TO 20
   25 TMX=X/UF
      RH=W*D/(2.*D+W)
      USTAR=6.7305*XN*UF/RH**(1./6.)
      DIST=7.*SQRT(4.*.0067*USTAR*RH*TMX)
      TYM=DIST/UF
      TMAXI=TMX+(TYM/2.)
      TMINI=TMX-(TYM/2.)
      IF(TMINI.LT.60.) TMINI=60.
   20 DT=(TMAXI-TMINI)/39.
      DO 10 I=1,40
      AT(I)=(FLOAT(I-1)*DT)+TMINI
      CALL DILUN(IFLAG,ICOND,ZMAS,ZMDOT,X,Y,Z,AT(I),DIFCO,D,W,A,UF,
     1           UT,TP,DEL,XK,XN,AC(I))
   10 CONTINUE
      IF(IFLAG.EQ.2) GO TO 13
      IF(AC(37).GT.0.0) GO TO 13
      I=36
      IF(ISTOP.EQ.1) GO TO 13
   12 IF(AC(I).GT.0.0) GO TO 11
      I=I-1
      IF(I.EQ.1) GO TO 13
      GO TO 12
   11 TMAXI=AT(I+1)
      ISTOP=1
      GO TO 20
C
C     GENERATE PLOT OF CONCENTRATION VS TIME AT USER SPECIFIED POINT
C
   13 CONTINUE
      DO 15 I=1,40
      ASAV(I)=AC(I)*1000000./DENL
      IF(ASAV(I).GT.1000000.) ASAV(I)=1000000.
   15 ASAVT(I)=AT(I)/60.
      IDC=0
      IF(IPPF.EQ.3) IDC=1
      IF(IPPF.EQ.1) IDC=1
      IF(IDC.NE.1) GO TO 70
      CALL PLTLP(PTITL ,ASAVT,ASAV,40,XTITL,YTITL ,1,60.,XTITL1)
C
C---------SET UP OFF-LINE PLOT
      PLTYP=7
      II=0
      JJ=20
      UX=UF
      TMINX=TMINI
      DO 16 I=1,40,2
      II=II+1
      JJ=JJ+1
      XBX(II)=AT(I)
   16 XBX(JJ)=AC(I)
C
C     GENERATE TABLE OF CONCENTRATION VS TIME AT USER SPECIFIED POINT.
C
   70 IF(ITAB.EQ.2) GO TO 80
      IF(ITAB.EQ.0) GO TO 80
      CALL PAGER(0)
      CALL PAGER(2)
      WRITE(6,71)
      CALL PAGER(3)
      WRITE(6,72)
      CALL PAGER(2)
      WRITE(6,73)
      DO 74 I=1,40
      CS=ASAV(I)*DENL
      CALL PAGER(1)
      WRITE(LP,75) ASAVT(I),ASAV(I),CS
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   74 CONTINUE
      CALL PAGER(2)
C
C    CALCULATE DATA FOR A TABLE OF CONCENTRATIONS VS. TIME AND
C    DISTANCE, AS APPROPRIATE,  FOR A NON-TIDAL FLOWING RIVER.
C
   80 IF(ITAB.LE.1.AND.IPPF.LE.1) GO TO 69
      IF(IFLAG.EQ.2) GO TO 5
      CALL PAGER(0)
      CALL PAGER(3)
      WRITE(LP,49)
    5 IF(IFLAG.NE.2) GO TO 99
      TMINI=60.
      YM=A
      ZM=0.0
      DT=(TMXP-TMINI)/39.
      XMINI=UF*TMINI
      DT=ABS(DT)
      DO 60 J=1,2
      DO 50 I=1,40
      ATIM(I)=TMINI+(FLOAT(I-1)*DT)
      AXD(I)=UF*ATIM(I)
      IF(ICOND.EQ.1) ATIM(I)=ATIM(I)+(ZMAS/(ZMDOT*2.))
C**ABOVE LINE INSERTED BY R.G. POTTS ON 3 NOV 1978
C**SETS TIME TO OBTAIN MAX CONCENTRATION AT LOC AXD(I)
      CALL DILUN(IFLAG,ICOND,ZMAS,ZMDOT,AXD(I),YM,ZM,ATIM(I),DIFCO,D,W,
     1A,UF,UT,TP,DEL,XK,XN,ACONC(I,J))
   50 CONTINUE
      ZM=D
   60 CONTINUE
C
C     GENERATE TABLE FROM DATA COMPUTED ABOVE
C
      CALL PAGER(0)
      CALL PAGER(4)
      IF(ICOND.EQ.0) WRITE(6,2000)
 2000 FORMAT (/12X,53HTABLE OF CONCENTRATION VS TIME AND DISTANCE - MODE
     1L P//)
      IF(ICOND.NE.0) WRITE(6,2010)
 2010 FORMAT (/11X,44HTABLE OF CONCENTRATION VS DISTANCE - MODEL P//)
      CALL PAGER(4)
      IF(ICOND.EQ.0) WRITE(6,2020)
 2020 FORMAT (1X,2(4X,10HDOWNSTREAM),6X,8HELAPSED ,2(2X,13HCONCENTRATION
     1)/2(6X,8HDISTANCE),8X,4HTIME,7X,10HAT SURFACE,4X,11HON RIVERBED/
     2 6X,8H(METERS),7X,6H(FEET),7X,9H(MINUTES),2(4X,10H(MG/LITER))/)
      IF(ICOND.NE.0) WRITE(6,2030)
 2030 FORMAT (1X,2(4X,10HDOWNSTREAM),2X,2(2X,13HCONCENTRATION)/2(6X,8HDI
     1STANCE),7X,10HAT SURFACE,4X,11HON RIVERBED/6X,8H(METERS),7X,6H(FEE
     2T),4X,2(4X,10H(MG/LITER))/)
      DO 65 I=1,40
      XMET=AXD(I)/100.
      TMNS=ATIM(I)/60.
      XFT=AXD(I)/(2.54*12.)
      IF(ACONC(I,1).GT.DENL) ACONC(I,1)=DENL
      IF(ACONC(I,2).GT.DENL) ACONC(I,2)=DENL
      TOPC=ACONC(I,1)*1000000.
      ACONC(I,1)=TOPC/DENL
      BOTC=ACONC(I,2)*1000000.
      ACONC(I,2)=BOTC/DENL
      CALL PAGER(1)
      IF(ICOND.EQ.0) WRITE(6,2040) XMET,XFT,TMNS,TOPC,BOTC
 2040 FORMAT (1X,5(4X,G10.4))
      IF(ICOND.NE.0) WRITE(6,2050) XMET,XFT,TOPC,BOTC
 2050 FORMAT (1X,2(4X,G10.4),2X,2(4X,G10.4))
   65 CONTINUE
      CALL PAGER(5)
      WRITE(6,2060)
 2060 FORMAT (/5X,63HNOTE: TABLE GIVES CONCENTRATIONS AT SURFACE AND ON
     1RIVERBED FOR/5X,66HDISTANCES DOWNSTREAM FROM THE SPILL LOCATION.
     2DOWNSTREAM DISTANCE/5X,65HIS GIVEN ALONG LINES ON THE SURFACE AND
     3RIVERBED SHIFTED FROM THE/5X,37HRIVER CENTERLINE BY THE SPILL OFFS
     4ET.)
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   69 CONTINUE
   99 CONTINUE
      RETURN
   31 FORMAT(/1X,35HTHIS CONCENTRATION IS EQUIVALENT TO,1X,G10.4,1X,7HPP
     1M AND,1X,G10.4,1X,9HMG/LITER.)
   40 FORMAT(/65H THE DIFFUSION COEFFICIENT OF THE CHEMICAL IN WATER IS
     1CALCULATED/)
   49 FORMAT(    /1X,43HTABLE OF CONCENTRATION VS TIME AND DISTANCE/1X,
     130HNOT APPROPRIATE FOR THIS CASE.)
   71 FORMAT(    /7X,59HTABLE OF CONCENTRATION VS TIME AT SPECIFIED POINT
     1 - MODEL P)
   72 FORMAT(//14X,12HELAPSED TIME,6X,13HCONCENTRATION,5X,13HCONCENTRATI
     1ON)
   73 FORMAT(17X,6H(MINS),13X,5H(PPM),11X,10H(MG/LITER)/)
   75 FORMAT(12X,G13.5,5X,G13.5,5X,G13.5)
   76 FORMAT(/5X,35HTHE COORDINATES FOR THIS TABLE ARE-)
      END
      OVERLAY(10,3)
      PROGRAM MODR
C
C         SUBROUTINE MODR OBTAINS THE NECESSARY DATA FOR THE EXECUTION
C         OF SUBROUTINE EVAMX, WHICH CALCULATES THE TOTAL MASS OF
C         VAPOR PRODUCED WHEN A WATER-MISCIBLE HIGH VAPOR PRESSURE
C         LIQUID IS SPILLED ON WATER AND MIXES WITH WATER DUE TO
C         TURBULENT DIFFUSION
      DATA MOD/4H  R /
C
C         OBTAIN NECESSARY DATA
C
    2 CONTINUE
      CALL TRACE(0,8,3)
      CALL BEGPR(MOD)
      LP=6
      IR=0
      IS=6
      CALL IRCL(2028,IFLAG,IS,IR)
      IF(IFLAG-2) 10,10,20
   20 IFLAG=2
      CALL PAGER(3)
      WRITE(LP,100)
   10 CONTINUE
      CALL FRCL(1002,XMOL,IS,IR)
      AM=XMOL
      IF(IFLAG.EQ.1) CALL FRCL(1003,TBOIL,IS,IR)
      CALL FRCL(1004,DENL,IS,IR)
      CALL FRCL(1010,ACR,IS,IR)
      CALL FRCL(1011,BCR,IS,IR)
      CALL FRCL(1012,CCR,IS,IR)
      CALL FRCL(1021,DLB,IS,IR)
      IF(IFLAG.EQ.1) CALL FRCL(1025,TCRIT,IS,IR)
      CALL FRCL(2023,TW,IS,IR)
      CALL FRCL(2054,TA,IS,IR)
      IF(IFLAG.NE.2) GO TO 1
      CALL FRCL(2044,D,IS,IR)
      CALL FRCL(2045,W,IS,IR)
      CALL FRCL(2047,US,IS,IR)
      CALL FRCL(2052,XN,IS,IR)
    1 CALL VAPPR(ACR,BCR,CCR,TW,PVAP)
C
C     CALCULATE MOLE FRACTIONS OF CHEMICAL IN WATER BELOW WHICH
C     FLAMMABLE AND TOXIC VAPORS CANNOT BE GENERATED.
C
      CALL FRCL(2032,CTOX,IS,IR)
      CALL FRCL(2033,CFIR,IS,IR)
      CTOX=CTOX/1000000.
      CFIR=CFIR/100.
      CSTMT=CTOX/PVAP
      CSTMF=CFIR/PVAP
C
C         CALCULATE DIFFUSION COEFFICIENT OF VAPOR WITH AIR
C
      CALL PAGER(3)
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      WRITE(LP,200)
      CALL COMPD(AM,TA,DLB,DIFVA)
      CALL FSV(2053,DIFVA,4)
      CALL FRCL(2053,DIFVA,IS,IR)
      CALL FRCL(4002,ZML,IS,IR)
C
C    CALCULATE DIFFUSION COEFFICIENT OF LIQUID CHEMICAL IN WATER
C
      IF(IFLAG.EQ.2) GO TO 60
      CALL PAGER(3)
      WRITE(LP,70)
      CALL CDIFW(AM,DLB,TW,TCRIT,TBOIL,DIFLW)
      DIFLW=1000.*DIFLW
      CALL FSV(2043,DIFLW,4)
      CALL FRCL(2043,DIFLW,IS,IR)
   60 CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 2
C
C          CALL EVAMX - THEN UPDATE DATA BASE
C
      CALL OUTPR(MOD)
      CSTM=CSTMT
      SMAX=0.0
      IFLG=0
      DO 30 I=1,2
      IF(CSTMT.EQ.0.0) IFLG=1
      IF(CSTM.EQ.0.0) GO TO 35
      CALL EVAMX(ZML,XMOL,ACR,BCR,CCR,DIFVA,DENL,DIFLW,IFLAG,D,W,US,XN
     *,TW,CSTM,ZMV,S,SIZMX,THAT)
      IF(IFLG.EQ.0.AND.I.EQ.2) GO TO 31
      CALL PAGER(2)
      IF(IFLG.EQ.0) WRITE(LP,50)
      IF(IFLG.EQ.1) WRITE(LP,40)
      CALL FSV(4023,ZMV,4)
      CALL FSV(4024,S,4)
      CALL FSV(2019,SIZMX,4)
      CALL FRCL(2019,SIZMX,IS,IR)
      SMAX=SIZMX
      FLOW=ZMV/THAT
       CALL FSV(4044,FLOW,4)
      CALL FSV(4045,THAT,4)
      TTM=THAT
      GO TO 35
   31 CALL PAGER(2)
      WRITE(LP,40)
      CALL FSV(4056,ZMV,4)
      CALL FSV(4057,S,4)
      CALL FSV(4058,SIZMX,4)
      FLOW=ZMV/THAT
      CALL FSV(4059,FLOW,4)
      CALL FSV(4060,THAT,4)
      GO TO  30
   35 CSTM=CSTMF
   30 CONTINUE
      IF(SMAX.EQ.0.0) SMAX=SIZMX
      CALL PAGER(2)
      WRITE(LP,39)
      SMAX=0.638*SMAX
      CALL FSV(2019,SMAX,6)
      CALL PAGER(1)
      WRITE(LP,38)
      IF(TTM.LT.600.) CALL ISV(2061,0,4)
      IF(TTM.GE.600.) CALL ISV(2061,1,4)
      CALL ISV(2018,2,4)
      CALL FSV(4068,TW,4)
      IF(TTM.GE.600.) GO TO 98
      CALL FRCL(4023,ZMV,IS,IR)
      CALL FSV(4001,ZMV,6)
   98 CALL ENDPR(MOD)
      GO TO 99
   38 FORMAT(52H THE VAPOR SOURCE PARAMETERS ARE ESTIMATED AS BEING-)
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   39 FORMAT(/1X,49HSIZE IS SET TO MEAN SIZE IN CASE MODEL S FOLLOWS.)
   40 FORMAT(1X,44HFOR THE LOWER FLAMMABLE LIMIT CONCENTRATION./)
   50 FORMAT(1X,28HFOR THE TOXIC CONCENTRATION./)
   70 FORMAT(/64H THE DIFFUSION COEFFICIENT OF CHEMICAL WITH WATER IS CA
     1LCULATED./)
  100 FORMAT(66H WARNING- MODEL R DOES NOT TAKE INTO ACCOUNT TIDAL EFFEC
     *TS. IT IS /42H ASSUMED THAT SPILL IS IN NON-TIDAL RIVER./)
  200 FORMAT(/59H THE DIFFUSION COEFFICIENT OF VAPOR WITH AIR IS CALCULA
     *TED./)
   99 CALL TRACE(1,8,3)
      END
      SUBROUTINE EVAMX(ZML,XMOL,ACR,BCR,CCR,DIFVA,DENL,DIFLW,IFLAG,D,W,
     *US,XN,TW,CSTM,ZMV,S,SIZMX,THAT)
C*********************************************************************
C
C  ***  THIS SUBROUTINE CALCULATES THE TOTAL MASS OF VAPOR PRODUCED WHEN
C       WATER MISCIBLE- HIGH VAPOR PRESSURE LIQUID IS SPILLED ON WATER A
C       MIXES WITH THE WATER DUE TO TURBULENT DIFFUSION.
C
C  ************  INPUT ARGUMENTS  ************
C  ***    ZML   = MASS OF LIQUID SPILLED                           GMS
C  ***    XMOL  = MOLECULAR WEIGHT OF THE LIQUID SPILLED
C  ***    ACR   = CONSTANTS IN THE VAPOR PRESSURE EQUATION  P=10**(ACR-BC
C  ***    BCR   =  ----------------'' --------------------
C  ***    CCR   = ---------------------' ' ----------------------
C  ***    DIFVA = DIFFUSION COEFFICIENT OF VAPOR IN AIR AT AMBIENT TEMP
C  ***    DENL  = DENSITY OF LIQUID AT THE SPILL TEMPERATURE        GM/C
C  ***    DIFLW = DIFFUSION COEFFICIENT OF LIQUID IN WATER           CM*
C  ***    IFLAG = A FLAG INDICATING THE LOCATION OF SPILL (1=STILL WATER,
C  ***            2=FLOWING, NON TIDAL RIVER
C  ***    D     = RIVER DEPTH  (TO BE GIVEN ONLY IF IFLAG=2)         CMS
C  ***    W     = RIVER WIDTH    -------- '' -----------              CMS
C  ***    US    = AVERAGE VELOCITY OF THE STREAM  ----  ''  ----      CM/
C  ***    XN    = STREAM ROUGHNESS FACTOR   ---  ''  -------
C  ***    TW    = WATER TEMPERATURE                                  DEG
C  ***    CSTM  = LIMITING VALUE OF THE MOLE FRACTION CONCENTRATION. THAT
C                 CONTRIBUTION TO EVAPORATION FROM WATER SURFACE REGIONS
C                 THIS CONCENTRATION IS NEGLIGIBLE.
C
C  ************  OUTPUT ARGUMENTS  ***********
C  ***    ZMV   = MASS OF VAPOR LIBERATED                            GMS
C  ***    S     = MAXIMUM DISTANCE IN THE STREAM DIRECTION BEYOND WHICH T
C                 CONCENTRATION IS EVERYWHERE LESS THAN 'CSTM'.      CMS
C  ***    SIZMX = MAXIMUM SIZE (RADIUS) OF THE SPREAD       CMS
C  ***    THAT  = TIME AT WHICH CONCENTRATION EVERYWHERE
C                 LESS THAN CSTM                                    SECS
C
C*********************************************************************
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      DIMENSION FX(101),ZM(101)
      EQUIVALENCE (XBX(1),FX(1))
      PI=3.141592654
      TP=0.
      T=0.
      UT=0.
      VOLI=ZML/DENL
      CALL HMTC(DIFVA,XMOL,VOLI,HMP)
      GO TO (10,20),IFLAG
10    EX=DIFLW
      EY=DIFLW
      EZ=DIFLW
      GO TO 30
20    CALL DISP(W,D,IFLAG,T,US,UT,XN,TP,E,EX,EY,EZ)
   30 CALL VAPPR(ACR,BCR,CCR,TW,PVAP)
      CSTAR=(CSTM/(1.-CSTM))*(XMOL/18.)
C
C  ***  CALCULATION OF THE CHARACTERISTIC CONSTANTS  *******
C
      THAT=(1./(4.*PI))*(2.*ZML/(CSTAR*SQRT(EX*EY*EZ)))**(2./3.)
      A=SQRT(4.*EX*THAT)
```

```
      B=SQRT(4.*EY*THAT)
      DZMCH=PI*A*B*HMP*PVAP
      ZMCHR =DZMCH *THAT
C
C  ***   INTEGRATION PREPARATION  ********
C
      N=101
      FX(1)=0.
      DO 40 I=2,N
      TOW=FLOAT(I-1)/FLOAT(N-1)
      CMAX=CSTAR/TOW**1.5
C
C  ***  'TOW' IS THE NON DIMENSIONAL TIME = TOME/THAT. CMAX IS THE MAXIM
C         CONCENTRATION AT ANY TIME IN GM/CM**3
C
      CMAXM=CMAX/(CMAX+XMOL/18.)
      IF(TOW-0.98) 50,50,60
50    CMENM=(CMAXM-CSTM)/ALOG(CMAXM/CSTM)
      GO TO 40
60    CMENM=CSTM
40    FX(I)=-1.5*TOW*CMENM*ALOG(TOW)
      FX(N)=0.
      DTOW=1./FLOAT(N-1)
C
C  ***   SIMPSON'S RULE INTEGRATION   ***********
C
      CALL QSF(DTOW,FX,ZM,N)
      ZMV=ZMCHR*ZM(N)
      S=US*THAT
      SIZMX=W/2.
      IF(SIZMX.GT.SQRT(EY*THAT)) SIZMX=SQRT(EY*THAT)
      RETURN
      END
      SUBROUTINE QSF(H,Y,Z,NDIM)
C*********************************************************************
C  ***   SIMPSON=S RULE INTEGRATION ROUTINE , FOR DETAILS SEE THE IBM MA
C
      DIMENSION Y(1),Z(1)
      HT=.3333333*H
      L1=1
      L2=2
      L3=3
      L4=4
      L5=5
      L6=6
      IF(NDIM-5)7,8,1
C     NDIM IS GREATER THAN 5. PREPARATIONS OF INTEGRATION LOOP
    1 SUM1=Y(L2)+Y(L2)
      SUM1=SUM1+SUM1
      SUM1=HT*(Y(L1)+SUM1+Y(L3))
      AUX1=Y(L4)+Y(L4)
      AUX1=AUX1+AUX1
      AUX1=SUM1+HT*(Y(L3)+AUX1+Y(L5))
      AUX2=HT*(Y(L1)+3.875*(Y(L2)+Y(L5))+2.625*(Y(L3)+Y(L4))+Y(L6))
      SUM2=Y(L5)+Y(L5)
      SUM2=SUM2+SUM2
      SUM2=AUX2-HT*(Y(L4)+SUM2+Y(L6))
      Z(L1)=0.
      AUX=Y(L3)+Y(L3)
      AUX=AUX+AUX
      Z(L2)=SUM2-HT*(Y(L2)+AUX+Y(L4))
      Z(L3)=SUM1
      Z(L4)=SUM2
      IF(NDIM-6)5,5,2
C     INTEGRATION LOOP
    2 DO 4 I=7,NDIM,2
      SUM1=AUX1
      SUM2=AUX2
      AUX1=Y(I-1)+Y(I-1)
      AUX1=AUX1+AUX1
      AUX1=SUM1+HT*(Y(I-2)+AUX1+Y(I))
      Z(I-2)=SUM1
```

```
      IF(I-NDIM)3,6,6
    3 AUX2=Y(I)+Y(I)
      AUX2=AUX2+AUX2
      AUX2=SUM2+HT*(Y(I-1)+AUX2+Y(I+1))
    4 Z(I-1)=SUM2
    5 Z(NDIM-1)=AUX1
      Z(NDIM)=AUX2
      RETURN
    6 Z(NDIM-1)=SUM2
      Z(NDIM)=AUX1
      RETURN
C     END OF INTEGRATION LOOP
    7 IF(NDIM-3)12,11,8
C     NDIM IS EQUAL TO 4 OR 5
    8 SUM2=1.125*HT*(Y(L1)+Y(L2)+Y(L2)+Y(L2)+Y(L3)+Y(L3)+Y(L3)+Y(L4))
      SUM1=Y(L2)+Y(L2)
      SUM1=SUM1+SUM1
      SUM1=HT*(Y(L1)+SUM1+Y(L3))
      Z(L1)=0.
      AUX1=Y(L3)+Y(L3)
      AUX1=AUX1+AUX1
      Z(L2)=SUM2-HT*(Y(L2)+AUX1+Y(L4))
      IF(NDIM-5)10,9,9
    9 AUX1=Y(L4)+Y(L4)
      AUX1=AUX1+AUX1
      Z(L5)=SUM1+HT*(Y(L3)+AUX1+Y(L5))
   10 Z(L3)=SUM1
      Z(L4)=SUM2
      RETURN
C     NDIM IS EQUAL TO 3
   11 SUM1=HT*(1.25*Y(L1)+Y(L2)+Y(L2)-.25*Y(L3))
      SUM2=Y(L2)+Y(L2)
      SUM2=SUM2+SUM2
      Z(L3)=HT*(Y(L1)+SUM2+Y(L3))
      Z(L1)=0.
      Z(L2)=SUM1
   12 RETURN
      END
      SUBROUTINE VAPPR(A,B,C,T,PVAP)
C**********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE VAOPR PRESSURE OF ANY COMPOUND AT T
C     GIVEN TEMPERATURE. THE EQUATION USED IS SIMILAR TO THE CLAUSIUS CL
C     EQUATION,NAMELY P = 10**(A-B/(T+C)).
C
C  ************  INPUT ARGUMENTS  ************
C  ***    A     = CONSTANT IN THE VAPOR EQUATION
C  ***    B     = CONSTANT IN THE VAPOR EQUATION
C  ***    C     = CONSTANT IN THE VAPOR EQUATION
C  ***    T     = TEMPERATURE AT WHICH THE VAPOR PRESSURE IS TO BE KNOWN
C  ************  OUTPUT ARGUMENTS  ***********
C
C  ***   PVAP  = VAPOR PRESSURE AT THE TEMPERATURE =T= .             ATM
C
C**********************************************************************
C
      PVAP=(10.**(A-(B/(T+C))))/760.
      RETURN
      END
      OVERLAY(10,4)
      PROGRAM MODT
C
C     SUBROUTINE MODT UTILIZES ROUTINES RLJSP,TSPRD, AND FTCON TO
C     CALCULATE THE CONDITIONS AFTER THE SPILL OF AN INSOLUBLE OR
C     SLIGHTLY SOLUBLE CHEMICAL WHICH IS LIGHTER-THAN-WATER AND HAS A
C     BOILING POINT GREATER THAN THE AMBIENT TEMPERATURE. SEE THOSE
C     ROUTINES FOR SPECIFIC CAPABILITIES.
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      DIMENSION PTITL(6),XTITL(6),XTITL1(6),YTITL(6),
     1          PTITL1(6),YTITL1(6)
```

```
      DIMENSION AT(20),AS(20),ASAVT(20),ASAVS(20),ASAV(20,2)
      EQUIVALENCE (XBX(64),IDIMX),(XBX(81),AT(1)),(XBX(101),AS(1))
      EQUIVALENCE (XBX(21),ASAVT(1)),(XBX(121),ASAVS(1))
      DATA MOD/4H  T /
     0DATA (PTITL (I),I=1,6)/8HPOOL RAD,8HIUS/LENG,8HTH VS TI,
     18HME - MOD,8HEL T    ,1H /
     0DATA (PTITL1(I),I=1,6)/8HCONCENTR,8HATION VS,8H TIME AT,
     18H A FIXED,8H POINT -,8H MODEL T/
     0DATA (XTITL (I),I=1,6)/8HELAPSED ,8HTIME FRO,8HM START ,
     18HOF SPILL,8H.......(,8HMINUTES)/
     0DATA (XTITL1(I),I=1,6)/8HELAPSED ,8HTIME FRO,8HM START ,
     18HOF SPILL,8H........,8H.(HOURS)/
     0DATA (YTITL (I),I=1,6)/8HPOOL RAD,8HIUS     ,8HOR LENGT,
     18HH       ,8H(METERS),1H /
     0DATA (YTITL1(I),I=1,6)/8H   CONCE,8HNTRATION,8H    AT P,
     18HOINT XYZ,1H ,1H /
   12 CONTINUE
      CALL TRACE(0,8,4)
      LP=6
      IR=0
      IS=6
      INDC=2
      PI=3.14159265
C
C        OBTAIN DATA
C
      CALL BEGPR(MOD)
      CALL IRCL(2086,MDTYP,IS,IR)
      IF(MDTYP.EQ.1) GO TO 5
C
C     WHEN MDTYP IS 0, THE MODEL FOR POOL SIZE VS TIME IS EXECUTED.
C     WHEN MDTYP IS 1, THE MODEL FOR CONCENTRATION AT XYZT IS EXECUTED.
C     WHEN MDTYP IS 2, BOTH THE ABOVE MODELS ARE EXECUTED.
C
      CALL IRCL(2058,INDC,IS,IR)
      IF(INDC.GE.1) IDIM=2
      CALL FRCL(1004,DENL,IS,IR)
C
C     THE DENSITY IS CHECKED TO ENSURE IT IS LESS THAN THAT OF WATER
      IF(DENL.LT.1.) GO TO 2
      CALL PAGER(5)
      WRITE(LP,3)
      DENL=0.99
    2 CONTINUE
C
      IF(INDC.EQ.0) CALL FRCL(1006,VISL,IS,IR)
      IF(INDC.EQ.0) CALL FRCL(1031,SURT,IS,IR)
      IF(INDC.GE.1) CALL FRCL(2008,DIA,IS,IR)
      IF(INDC.EQ.0) CALL FRCL(2020,CHNLW,IS,IR)
      IF(INDC.GE.1) CALL FRCL(4049,FLOW,IS,IR)
      IF(INDC.GE.1) CALL FRCL(4050,ENDTM,IS,IR)
      CALL FRCL(2056,TIME,IS,IR)
      IF (INDC.GE.1) CALL FRCL(2059,HGT,IS,IR)
      CALL FRCL(4002,SPAMT,IS,IR)
      VOL=SPAMT/DENL
      IF(MDTYP.EQ.0) GO TO 6
    5 CALL FRCL(1002,AM,IS,IR)
      CALL FRCL(1003,TBOIL,IS,IR)
      IF(MDTYP.EQ.1) CALL FRCL(1004,DENL,IS,IR)
C
C     THE DENSITY IS CHECKED TO ENSURE IT IS LESS THAN THAT OF WATER
      IF(MDTYP.NE.1.OR.DENL.LT.1.) GO TO 4
      CALL PAGER(5)
      WRITE(LP,3)
      DENL=0.99
    4 CONTINUE
C
      IF(MDTYP.EQ.1.OR.INDC.EQ.1) CALL FRCL(1006,VISL,IS,IR)
      CALL FRCL(1008,SURFC,IS,IR)
      CALL FRCL(1021,DENLB,IS,IR)
      CALL FRCL(1025,TCRIT,IS,IR)
      IF(MDTYP.EQ.1.OR.INDC.EQ.1) CALL FRCL(2020,CHNLW,IS,IR)
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      WW=CHNLW
      CALL FRCL(2023,TWAT,IS,IR)
      CALL FRCL(2039,X ,IS,IR)
      CALL FRCL(2040,Y ,IS,IR)
      CALL FRCL(2041,Z ,IS,IR)
      CALL FRCL(2042,T ,IS,IR)
      CALL PAGER(3)
      WRITE(LP,7)
      CALL CDIFW(AM,DENLR,TWAT,TCRIT,TBOIL,DIFCO)
      CALL FSV(2043,DIFCO,4)
      CALL FRCL(2043,DIFCO,IS,IR)
      CALL FRCL(2044,DW,IS,IR)
      CALL FRCL(2047,US,IS,IR)
      CALL FRCL(2052,XN,IS,IR)
      IF(MDTYP.EQ.1.OR.INDC.EQ.1) CALL FRCL(4002,SPAMT,IS,IR)
C
C     CALL ROUTINE SOLUB TO FIND SOLUBILITY OF CHEMICAL IN WATER
C     SOLUB CALLS DATA OF FIELD NUMBERS 1026, 1028, AND 1029.
      CALL SOLUB(TWAT,CSAT,IS,IR)
      CSAT=CSAT/100.0
C
    6 CONTINUE
      CALL IRCL(3009,ITPF,IS,IR)
C
C     IF ITPF IS 0, NO PLOTS ARE PRODUCED.
C     IF ITPF IS 1, A PLOT OF POOL SIZE VS TIME IS GIVEN.
C     IF ITPF IS 2, A PLOT OF CONCENTRATION AT A USER SPECIFIED POINT
C                   VS TIME IS GENERATED.
C     IF ITPF IS 3, BOTH PLOTS DESCRIBED ABOVE ARE GENERATED.
C
      CALL IRCL(3017,ITAB,IS,IR)
C     IF ITAB IS 0, NO TABLES ARE PRODUCED.
C     IF ITAB IS 1, GIVES TABLE OF POOL SIZE VS TIME.
C     IF ITAB IS 2, GIVES TABLE OF PEAK CONC AT MIDDLE AND BOTTOM OF
C     RIVER VS TIME AND DISTANCE.
C     IF ITAB IS 3, GIVES TABLE OF CONC VS TIME AT SPECIFIED XYZ.
C     IF ITAB IS 4, GIVES LAST TWO TABLES DESCRIBED.
C     IF ITAB IS 5, GIVES ALL OF THE ABOVE.
C
      IF(ITPF.NE.0.OR.ITAB.NE.0) CALL FRCL(2055,TMXT,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 12
      IF(MDTYP.EQ.1) GO TO 50
      IF(INDC.LE.0) GO TO 20
C
C     CALL TSPRD FOR CONTINUOUS RELEASES
C
      SIZMX=-1.
      CALL TSPRD(DENL,DIA,HGT,FLOW,TIME,SIZE)
      IF(TIME.LT.ENDTM) GO TO 19
      VL=FLOW*ENDTM
      AIREA=VL/0.01
      SIZMX=SQRT(AIREA/PI)
      IF(SIZE.GT.SIZMX) SIZE=SIZMX
   19 DIAM=2.*SIZE
      CALL OUTPR(MOD)
      CALL FSV(4025,SIZE,4)
      CALL FSV(4007,DIAM,4)
      IF(SIZE.EQ.SIZMX) CALL PAGER(6)
      IF(SIZE.EQ.SIZMX) WRITE(LP,18)
      GO TO 50
   20 IDIM=2
C
C     CALL RLJSP FOR INSTANTANEOUS RELEASES
C
      CALL RLJSP(IDIM,VOL,DENL,VISL,SURT,TIME,CHNLW,SIZE)
      AREA=SIZE*SIZE*PI
      THICK=VOL/AREA
      IF(THICK.LT.0.01) SIZE=SQRT(VOL/(0.01*PI))
      DIAM=2.*SIZE
      IF(DIAM.LE.CHNLW) GO TO 15
```

```
      IDIM=1
      CALL RLJSP(IDIM,VOL,DENL,VISL,SURT,TIME,CHNLW,SIZE)
      AREA=CHNLW*SIZE
      THICK=VOL/AREA
      IF(THICK.LT.0.01) SIZE=VOL/(0.01*CHNLW)
   15 CALL OUTPR(MOD)
      CALL PAGER(1)
      IF(IDIM.EQ.2) WRITE(LP,31)
      IF(IDIM.EQ.1) WRITE(LP,25)
      CALL FSV(4025,SIZE,4)
      DIAM=2.*SIZE
      IF(IDIM.EQ.1) DIAM=SQRT(SIZE*CHNLW*4./3.14159)
      CALL FSV(4007,DIAM,4)
      CALL PAGER(4)
      WRITE(LP,16)
   50 IF(MDTYP.EQ.0) GO TO 30
C
C     CALL FTCON TO FIND CONCENTRATION AT USER SPECIFIED POINT
C
      CALL FTCON(DW,WW,US,DIFCO,CSAT,SPAMT,DENL,VISL,SURFC,XN,T,X,Y,Z,
     1            DISRT,DISTM,PLCNX,CONC)
      IF(CONC.GT.DENL) CONC=DENL
      IF(MDTYP.EQ.1) CALL OUTPR(MOD)
      CALL FSV(4061,DISRT,4)
      CALL FSV(4062,DISTM,4)
      CALL FSV(4063,PLCNX,4)
      CALL FSV(4064,CONC,4)
      CONC=CONC*1000000.0
      CPPM=CONC/DENL
      CALL PAGER(2)
      WRITE(LP,51) CPPM,CONC
   30 CALL ENDPR(MOD)
C
C     INTERROGATE USER PLOT AND TABLE REQUEST FLAGS
C
      IF(ITPF.EQ.0.AND.ITAB.EQ.0) GO TO 99
      IF(ITPF.EQ.1.OR.ITPF.EQ.3) GO TO 8
      IF(ITAB.EQ.1.OR.ITAB.EQ.5) GO TO 8
      GO TO 1
    8 DT=TMXT/20.0
      IF(MDTYP.EQ.1) GO TO 1
C
C         SET UP LOOP FOR CALCULATION OF PLOT ARRAYS OF SIZE OF LIQUID
C         POOL VERSUS ELAPSED TIME
C
      ISVI=0
      IDM=2
      DO 10 I=1,20
      AT(I)=(FLOAT(I-1)*DT)+DT
      IF(INDC.LE.0) GO TO 11
      CALL TSPRD(DENL,DIA,HGT,FLOW,AT(I),AS(I))
      IF(AT(I).GT.ENDTM.AND.AS(I).GT.SIZMX) AS(I)=SIZMX
   11 CONTINUE
      IF(INDC.LE.0) CALL RLJSP(IDM,VOL,DENL,VISL,SURT,AT(I),CHNLW,AS(I))
      IF(INDC.EQ.1) GO TO 9
      IF(IDM.EQ.2) AREA=AS(I)*AS(I)*PI
      IF(IDM.EQ.1) AREA=CHNLW*AS(I)
      THICK=VOL/AREA
      IF(THICK.LT.0.01.AND.IDM.EQ.2) AS(I)=SQRT(VOL/(0.01*PI))
      IF(THICK.LT.0.01.AND.IDM.EQ.1) AS(I)=VOL/(0.01*CHNLW)
    9 CONTINUE
      IF(ISVI.GT.0.OR.INDC.EQ.1) GO TO 10
      DIAMT=2.*AS(I)
      IF(DIAMT.GT.CHNLW) IDM=1
      IF(DIAMT.GT.CHNLW) ISVI=I
   10 CONTINUE
      IF(ITAB.NE.1.AND.ITAB.NE.5) GO TO 26
C
C     WRITE TABLE OF POOL SIZE VS TIME
C
      CALL PAGER(0)
      CALL PAGER(4)
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      WRITE(LP,21)
      CALL PAGER(1)
      WRITE(LP,22)
      CALL PAGER(1)
      WRITE(LP,23)
      DO 40 I=1,20
      ATM=AT(I)/60.
      ASM=AS(I)/100.
      ASFT=AS(I)/(2.54*12.)
      CALL PAGER(1)
      WRITE(LP,24) AT(I),ATM,AS(I),ASM,ASFT
   40 CONTINUE
      STM=(FLOAT(ISVI)-1.)*DT/60.0
      IF(ISVI.GT.0.AND.INDC.EQ.0) CALL PAGER(3)
      IF(ISVI.GT.0.AND.INDC.EQ.0) WRITE(LP,27) STM
      CALL PAGER(4)
      WRITE(LP,16)
   26 IF(ITPF.EQ.0.OR.ITPF.EQ.2) GO TO 1
C
C     WRITE PLOT OF POOL SIZE VS TIME
C
C
C--------SET UP FOR FIRST OFF-LINE PLOT
      PLTYP=8
      IDIMX=IDIM
      II=0
      JJ=40
      DO 700 IX=1,20
      II=II+1
      JJ=JJ+1
      XBX(II)=AT(IX)
  700 XBX(JJ)=AS(IX)
      DO 41 I=1,20
      ASAVT(I)=AT(I)/60.
   41 ASAVS(I)=AS(I)/100.
      CALL PLTLP(PTITL,ASAVT,ASAVS,20,XTITL,YTITL,1,60.,XTITL1)
      STM=(FLOAT(ISVI)-1.)*DT/60.
      IF(ISVI.GT.0.AND.INDC.EQ.0) CALL PAGER(3)
      IF(ISVI.GT.0.AND.INDC.EQ.0) WRITE(LP,27) STM
    1 CONTINUE
      IF(ITAB.NE.2.AND.ITAB.LT.4) GO TO 90
      IF(MDTYP.EQ.0) GO TO 99
C
C     COMPUTE DATA FOR A TABLE OF PEAK CONCENTRATIONS AT MID-DEPTH AND
C     BOTTOM DEPTHS OF RIVER VS TIME AND DISTANCE.
C
      ZZ=DW/2.
      YY=0.0
      DT=TMXT/20.
      DO 60 II=1,2
      DO 70 I=1,20
      AT(I)=DT+(FLOAT(I-1)*DT)
      AS(I)=US*AT(I)
      CALL FTCON(DW,WW,US,DIFCO,CSAT,SPAMT,DENL,VISL,SURFC,XN,AT(I),AS(I
     1           ),YY,ZZ,DISRT,DISTM,PLCNX,ASAV(I,II))
      IF(ASAV(I,II).GT.DENL) ASAV(I,II)=DENL
      ASAV(I,II)=ASAV(I,II)*1000000.0/DENL
   70 CONTINUE
      ZZ=DW
   60 CONTINUE
C
C     WRITE TABLE OF PEAK CONCENTRATIONS AT MID-DEPTH AND BOTTOM  DEPTHS
C     OF RIVER VS TIME AND DISTANCE.
C
      CALL PAGER(0)
      CALL PAGER(6)
      WRITE(LP,52)
      CALL PAGER(1)
      WRITE(LP,53)
      CALL PAGER(3)
      WRITE(LP,35)
      DO 80 I=1,20
```

```
      XMET=AS(I)/100.
      XFT=XMET*3.281
      TMNS=AT(I)/60.
      THRS=TMNS/60.
      CALL PAGER(1)
      WRITE(LP,54) XMET,XFT,TMNS,THRS,ASAV(I,1),ASAV(I,2)
   80 CONTINUE
      CALL PAGER(5)
      WRITE(LP,55)
      IF(MDTYP.EQ.0) GO TO 99
   90 IF(ITAB.LT.3.AND.ITPF.LT.2) GO TO 99
C
C     COMPUTE DATA FOR A TABLE OR PLOT OF CONCENTRATION VS TIME AT A
C     USER SPECIFIED POINT XYZ
C
      TS=X/US
      IF(TS.LE.0.0) TS=1.
      TS1=TS
   91 CALL FTCON(DW,WW,US,DIFCO,CSAT,SPAMT,DENL,VISL,SURFC,XN,TS,X,Y,Z,
     1           DISRT,DISTM,PLCNX,CONC)
      CONC=CONC*1000000.0/DENL
      IF(CONC.GT.10.) TS=TS-(TS1/50.)
      IF(CONC.GT.10.0.AND.TS.LT.0.0) TS=0.01
      IF(CONC.GT.10.0.AND.TS.EQ.0.01) GO TO 96
      IF(CONC.GT.10.0) GO TO 91
      IF(TS.EQ.TS1) TS=TS1-300.0
      IF(TS.LT.0.0) TS=0.01
   96 DT=2.*(TS1-TS)/19.
      IF(DT.LT.3.16) DT=60./19.
      DO 92 I=1,20
      AT(I)=TS+(FLOAT(I-1)*DT)
      CALL FTCON(DW,WW,US,DIFCO,CSAT,SPAMT,DENL,VISL,SURFC,XN,AT(I),X,Y,
     1           Z,DISRT,DISTM,PLCNX,AS(I))
   92 CONTINUE
C
C     WRITE A TABLE OF CONCENTRATION VS TIME AT A USER SPECIFIED POINT.
C
      IF(ITAB.LT.3) GO TO 94
      CALL PAGER(0)
      CALL PAGER(5)
      WRITE(LP,56)
      CALL PAGER(1)
      WRITE(LP,57)
      CALL PAGER(1)
      WRITE(LP,58)
   94 DO 93 I=1,20
      AT(I)=AT(I)/60.
      THRS=AT(I)/60.
      IF(AS(I).GT.DENL) AS(I)=DENL
      AS(I)=AS(I)*1000000.0/DENL
      CMGL=AS(I)*DENL
      IF(ITAB.LT.3) GO TO 93
      CALL PAGER(1)
      WRITE(LP,59) AT(I),THRS,AS(I),CMGL
   93 CONTINUE
      IF(ITAB.LT.3) GO TO 95
      CALL PAGER(2)
      WRITE(LP,61)
      CALL FRCL(2039,X,IS,IR)
      CALL FRCL(2040,Y,IS,IR)
      CALL FRCL(2041,Z,IS,IR)
   95 IF(ITPF.LT.2) GO TO 99
C
C     WRITE PLOT OF CONCENTRATION VS TIME AT USER SPECIFIED POINT.
C
      CALL PLTLP(PTITL1,AT,AS,20,XTITL,YTITL1,1,60.,XTITL1)
C
C--------SET UP FOR SECOND OFF-LINE PLOT
      ITMP=PLTYP
      IF(ITMP.EQ.0) PLTYP=9
      IF(ITMP.EQ.8) PLTYP=10
      DO 701 I=1,20
```

```
701 AT(I)=60.*AT(I)
    GO TO 99
   30FORMAT(/5X,58HWARNING - THE DENSITY OF THIS SUBSTANCE HAS BEEN EST
    1IMATED/5X,57HAS BEING THE SAME AS OR GREATER THAN THAT OF WATER. U
    2NDER/5X,70HTHESE CONDITIONS, THE MODEL ASSUMES THAT ITS DENSITY IS
    3 0.99 GM/CM**3./)
   7 FORMAT(/65H THE DIFFUSION COEFFICIENT OF THE CHEMICAL IN WATER IS
    1CALCULATED/)
  16 FORMAT(/6X,54H*** THIS ANALYSIS ASSUMES THE POOL WILL STOP SPREADI
    1NG/10X,39HWHEN ITS THICKNESS IS 0.01 CENTIMETERS./)
  18 FORMAT(/6X,49H*** SINCE THE FLOW FROM THE TANK STOPS BEFORE THE/10
    1X,49HTIME AT WHICH THESE POOL SIZES WERE COMPUTED, THE/10X,47HMODE
    2L ASSUMES THE POOL STOPS SPREADING WHEN ITS/10X,30HTHICKNESS IS 0.
    301 CENTIMETERS./)
  21 FORMAT(/21X,27HPOOL SIZE VS TIME - MODEL T//)
  22 FORMAT( 8X,4HTIME,8X,4HTIME,8X,4HSIZE,8X,4HSIZE,8X,4HSIZE)
  23 FORMAT( 7X,6H(SECS),6X,6H(MINS),7X,5H(CMS),8X,3H(M),8X,4H(FT)//)
  24 FORMAT( 5X,G10.4,2X,G10.4,2X,G10.4,2X,G10.4,2X,G10.4)
  25 FORMAT(1X,46H THE SPILL POOL IS CONFINED BY CHANNEL BANKSO )
  27 FORMAT(/17X,34H*** NOTE - AT APPROXIMATELY TIME =,G10.4,13H MINUTE
    1S, ***/17X,45H*** THE POOL IS CONFINED BY CHANNEL BANKS ***)
  31 FORMAT(1X,29H THE SPILL POOL IS CIRCULAR. )
  35 FORMAT(5X,3H(M),9X,4H(FT),8X,6H(MINS),8X,5H(HRS),8X,5H(PPM),8X,5H(
    1PPM)//)
  51 FORMAT(/6X,35HTHIS CONCENTRATION IS EQUIVALENT TO,1X,G10.4,1X,7HPP
    1M AND,1X,G10.4,1X,9HMG/LITER.)
  52 FORMAT(//16X,48HTABLE OF PEAK CONCENTRATION VS TIME AND DISTANCE/
    119X,41HAT MIDDEPTH AND BOTTOM OF RIVER - MODEL T//)
  53 FORMAT(1X,10HX-DISTANCE,3X,10HX-DISTANCE,6X,4HTIME,9X,4HTIME,7X,
    18HMID CONC,5X,8HBOT CONC)
  54 FORMAT(1X,6(G10.4,3X))
  55 FORMAT(//1X,55HNOTE - A CONCENTRATION IN PPM MULTIPLIED BY THE DEN
    1SITY/1X,53HOF THE SPILLED CHEMICAL IN UNITS OF G/CM**3 GIVES THE/
    21X,26HCONCENTRATION IN MG/LITER.)
  56 FORMAT(//1X,64HTABLE OF CONCENTRATION VS TIME AT USER SPECIFIED PO
    1INT - MODEL T//)
  57 FORMAT(4X,4HTIME,11X,4HTIME,11X,4HCONC,11X,4HCONC)
  58 FORMAT(3X,6H(MINS),10X,5H(HRS),10X,5H(PPM),7X,10H(MG/LITER)//)
  59 FORMAT(1X,4(G10.4,5X))
  61 FORMAT(/5X,35HTHE COORDINATES FOR THIS TABLE ARE-)
  99 CALL TRACE(1,8,4)
     END
     SUBROUTINE FTCON(DW,WW,US,DIFW,CSAT,SPAMT,DENL,VISL,SURT,XN,T,X,Y,
    1Z,DISRT,DISTM,PLCNX,CONC)
C
C***********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE DISSOLUTION RATE, TIME FOR ALL
C     CHEMICAL TO DISSOLVE, DOWNSTREAM CONCENTRATION AT A USER SPECIFIED
C     TIME AND LOCATION, AND THE DISTANCE DOWNSTREAM THE CENTER OF THE
C     SPILL POOL HAS TRAVELED AT THE USER SPECIFIED TIME.  THE ROUTINE
C     IS PRIMARILY WRITTEN FOR A SPILL POOL WHOSE DIAMETER DOES NOT
C     EXCEED THE WIDTH OF THE WATERBODY WHERE THE SPILL OCCURS, BUT
C     IS APPROXIMATELY CORRECT FOR THE ALTERNATE CASE.  IT IS MEANT ONLY
C     TO BE USED UNDER STEADY-STATE FLOW CONDITIONS, I.E. A NON-TIDAL
C     WATERBODY.
C
C          *****INPUTS*****
C
C     DW    = DEPTH OF RIVER                                      CMS
C     WW    = WIDTH OF RIVER                                      CMS
C     US    = MEAN STREAM VELOCITY                                CM/SEC
C     DIFW  = DIFFUSION COEFFICIENT OF LIQUID IN WATER            CM2/SEC
C     CSAT  = SOLUBILITY OF CHEMICAL IN WATER                     GM/GM
C     SPAMT= AMOUNT OF CHEMICAL SPILLED                           GM
C     DENL  = DENSITY OF CHEMICAL SPILLED                         GM/CM3
C     VISL  = VISCOSITY OF CHEMICAL SPILLED                       GM/CM-S
C     SURT  = SURFACE TENSION OF CHEMICAL SPILLED                 D/CM
C     XN    = MANNING ROUGHNESS FACTOR FOR RIVER                  NON-DIM
C     T     = TIME AT WHICH DOWNSTREAM CONCENTRATION DESIRED      SECS
C     X     = DOWNSTREAM DISTANCE FROM SPILL SITE AT WHICH
C             CONCENTRATION DESIRED                               CM
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C      Y     = DISTANCE FROM MIDSTREAM AT WHICH CONCENTRATION
C                IS DESIRED                                           CM
C      Z     = DEPTH IN RIVER AT WHICH CONCENTRATION DESIRED          CM
C
C          *****OUTPUTS*****
C
C      DISRT= DISSOLUTION RATE OF CHEMICAL                        GM/CM2-SEC
C      DISTM= TIME FOR ALL CHEMICAL TO DISSOLVE                      SECS
C      PLCNX= DISTANCE DOWNSTREAM POOL CENTER HAS TRAVELED BY
C             USER SPECIFIED TIME "T"                                 CM
C      CONC = CONCENTRATION OF CHEMICAL IN WATER AT SPECIFIED
C             TIME AND LOCATION                                       GM/CM3
C
C*************************************************************************
C
      DATA DENW,PI,IDIM,CHNLW,AREA/1.0,3.14159265,2,10000.,1.0/
C
C     CALCULATE DISSOLUTION RATE IN GM/CM2-SEC
C
      VOL=SPAMT/DENL
      SCLEN=0.1*DW
      USQBR=0.1*US
      BARK=1.46*SQRT(DIFW*USQBR/SCLEN)
      DISRT=BARK*DENW*CSAT
C
C     FIND TIME AT WHICH ALL CHEMICAL HAS DISSOLVED
C
      ISTOP=0
      THICK=0.05
      AREAC=SPAMT/(THICK*DENL)
      DT=300.0
      TIME=DT
   40 CALL RLJSP(IDIM,VOL,DENL,VISL,SURT,TIME,CHNLW,SIZE)
      AREA=PI*SIZE*SIZE
      IF(AREA.GT.AREAC) AREA=AREAC
      AREA=0.707*AREA
      AMTDS=DISRT*AREA*TIME
      IF(AMTDS-SPAMT) 25,20,20
   25 IF(ISTOP.EQ.1) GO TO 26
      TIME=2.*TIME
      GO TO 40
   20 ISTOP=1
      TIME=TIME-120.0
      IF(TIME.LE.0.0) TIME=60.
      IF(TIME.EQ.60.) GO TO 26
      GO TO 40
   26 DISTM=TIME
C
C     CALCULATE CONCENTRATION IN WATER
C
      RH=WW*DW/(2.*DW+WW)
      USTAR=6.7305*XN*US/RH**(1./6.)
      EZ=0.067*USTAR*RH
      EX=0.1*EZ
      IF(WW/DW-100.) 10,5,5
    5 EY=0.1*EZ
      GO TO 15
   10 EY=0.23*USTAR*RH
   15 SX=2.*SQRT(EX*T)
      SY=2.*SQRT(EY*T)
      SZ=2.*SQRT(EZ*T)
      XBAR=X-(US*T)
      YBAR=Y
      ZBAR=Z
      W=SQRT(AREA)
      A=XBAR/SX
      A=A*A
      B=(YBAR/SY)**2.
      C=((YBAR+W)/SY)**2.
      D=(YBAR-W)/SY
      D=D*D
      E=(ZBAR/SZ)**2
```

```
      F=((ZBAR-2.*DW)/SZ)**2
      G=((ZBAR+2.*DW)/SZ)**2
      CONC=CSAT*EXP(-A)*(EXP(-B)+EXP(-C)+EXP(-D))*(EXP(-E)+EXP(-F)+EXP(-
     1G))
      PLCNX=US*T
      RETURN
      END
      SUBROUTINE TSPRD(DENL,DIA,HGT,FLOW,TIME  IZE)
C
C***********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE POOL RADIUS AS A FUNCTION OF TIME
C     FOR AN INSOLUBLE, LIGHTER-THAN-WATER CHEMICAL WITH BOILING POINT
C     GREATER THAN AMBIENT SPILLED CONTINUOUSLY ONTO WATER.  IT WORKS
C     ONLY FOR RADIAL SPREADING.
C
C  *** INPUTS ***
C
C     DENL   DENSITY OF SPILLED CHEMICAL                      GM/CM3
C     DIA    AVERAGE DIAMETER OF HOLE                         CM
C     HGT    HEIGHT OF HOLE ABOVE WATER                       CM
C     FLOW   CONTINUOUS MASS RATE OF FLOW                     GM/SEC
C     TIME   TIME AT WHICH POOL RADIUS DESIRED                SECS
C
C  *** OUTPUTS ***
C
C     SIZE   RADIUS OF POOL AT SPECIFIED TIME                 CM
C
C***********************************************************************
C
      PI=3.141592654
      G=980.
      DENW=1.0
C     CALCULATING THE JET ENTRY PARAMETERS, HYDRAULIC JUMP RADIUS
C     AND THE RADIAL OUTFLOW VELOCITY.
      FLW=FLOW/DENL
      GRAV=G*(1.-DENL/DENW)
      VEL=FLW/((PI/4.)*DIA*DIA)
      U=SQRT((VEL**2.)+(2.*G*HGT))
      A=DIA*SQRT(VEL/U)/2.
      HB=A/2.
      FB=2.*U*U/(GRAV*A)
      FA=8.*FB/((SQRT((8.*FB)+1.)-1.)**3.)
      HA=HB*(FB/FA)**(1./3.)
      UA=U*HB/HA
C     CALCULATING THE RADIAL SPREAD PARAMETERS.
      TCH=A/UA
      TAU=TIME/TCH
      F=UA*UA/(HA*GRAV)
      E1=0.41
      E0=0.68
      PSI1=SQRT(2./(1.-(2.*E1)))*SQRT(TAU-((F*E1)/((1.-E1-E1)**2.)))
      CHI=PSI1+1.
      SIZE=CHI*A
      RETURN
      END
      OVERLAY(10,5)
      PROGRAM MODV
C
C         SUBROUTINE MODV OBTAINS DATA FOR THE EXECUTION OF SUBROUTINE
C         PKRHI, WHICH CALCULATES THE CONDITIONS AFTER WHOSE BOILING
C         POINT IS GREATER THAN AMBIENT
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      DIMENSION AT(20),AV(20),AS(20),ATEM(20),AER(20),AR(20)
      DIMENSION ASAV(20),ASAVT(20), PTITL1(6),PTITL2(6),PTITL3(6),
     1PTITL4(6),PTITL5(6),XTITL(6),XTITL1(6),YTITL1(6),YTITL2(6),
     1YTITL3(6),YTITL4(6),YTITL5(6)
      EQUIVALENCE (XBX(1),AT(1)),(XBX(21),AV(1)), (XBX(41),AS(1)),
     1            (XBX(61),ATEM(1)),(XBX(81),AER(1)),(XBX(101),AR(1))
      EQUIVALENCE (XBX(121),ASAV(1))
```

```
      DATA MOD/4H  V /
     0DATA (PTITL1(I),I=1,6)/8HPOOL RAD,8HIUS/LENG,8HTH VS TI,
     18HME - MOD,8HEL V    ,1H /
     0DATA (PTITL2(I),I=1,6)/8HVOLUME O,8HF LIQUID,8H REMAINI,
     18HNG VS TI,8HME - MOD,8HEL V    /
     0DATA (PTITL3(I),I=1,6)/8HEVAPORAT,8HION RATE,8H VS TIME,
     18H - MODEL,8H V      ,1H /
     0DATA (PTITL4(I),I=1,6)/8HPOOL ARE,8HA VS TIM,8HE MODEL ,
     18HV      ,1H ,1H /
     0DATA (PTITL5(I),I=1,6)/8HTERPERAT,8HURE OF L,8HIQUID VS,
     18H TIME - ,8HMODEL V ,1H /
     0DATA (XTITL (I),I=1,6)/8HELAPSED ,8HTIME FRO,8HM START ,
     18HOF SPILL,8H.......(,8HMINUTES)/
     0DATA (XTITL1(I),I=1,6)/8HELAPSED ,8HTIME FRO,8HM START ,
     18HOF SPILL,8H........,8H.(HOURS)/
     0DATA (YTITL1(I),I=1,6)/8H   RADIU,8HS/LENGTH,8H       O,
     18HF POOL  ,8H       (,8HMETERS) /
     0DATA (YTITL2(I),I=1,6)/1H ,8H VOLUME ,8H      RE,
     18HMAINING ,1H ,8H (M**3) /
     0DATA (YTITL3(I),I=1,6)/8H     EVA,8HPORATION,1H ,
     18H    RATE,8H       (,8HKG/SEC) /
     0DATA (YTITL4(I),I=1,6)/1H ,8H   AREA ,1H ,
     18HOF POOL ,1H ,8H (M**2) /
     0DATA (YTITL5(I),I=1,6)/8H    TEMP,8HERATURE ,8H      OF,
     18H LIQUID ,1H ,8H(DEG C) /
    2 CONTINUE
      CALL TRACE(0,8,5)
      IR=0
      LP=6
      IS=6
C
C        OBTAIN DATA
C
      CALL BEGPR(MOD)
      CALL FRCL(1002,XMOL,IS,IR)
      AM=XMOL
      CALL FRCL(1004,DENL,IS,IR)
      IF(DENL-1.0) 40,30,30
   30 CALL PAGER(4)
      WRITE(LP,100)
      DENL=0.99
   40 CONTINUE
      CALL FRCL(1006,VISL,IS,IR)
      IOUT=0
      CALL FRCL(1007,CL,IS,IR)
      CALL FRCL(1010,A,IS,IR)
      CALL FRCL(1011,B,IS,IR)
      CALL FRCL(1012,C,IS,IR)
      CALL FRCL(1014,XLAT,IS,IR)
      CALL FRCL(1021,DENLB,IS,IR)
      CALL FRCL(1031,SURT,IS,IR)
      CALL FRCL(2004,TINT,IS,IR)
      CALL FRCL(2020,CHNLW,IS,IR)
      CALL FRCL(2023,TW,IS,IR)
      CALL FRCL(2033,CFIR,IS,IR)
      CALL FRCL(2054,TA,IS,IR)
      TMAX=TW
      IF(TA.GT.TMAX) TMAX=TA
      IF(TINT.GT.TMAX) TMAX=TINT
      PRES=10.**(A-(B/(TMAX+C)))
      CONC=100.*PRES/760.
      CALL FRCL(2057,TIME,IS,IR)
      IS1=6
      CALL FRCL(4003,VOLI,IS1,IR)
C---------IF VOLUME IS NOT A DEFAULT, USE GIVEN VALUE
C          OTHERWISE, COMPUTE USING MASS AND DENSITY
      IF(IS1.GT.1) GO TO 300
      CALL PAGER(1)
      WRITE(LP,310)
      CALL FRCL(4002,SPAMT,IS,IR)
      VOLI=SPAMT/DENL
      CALL FSV(4003,VOLI,4)
```

```
      IS1=4
  300 IF(IS.GT.IS1) IS=IS1
      CALL PAGER(1)
      WRITE(LP,21)
      CALL COMPD(AM,TA,DENLB,DIFCO)
      CALL FSV(2053,DIFCO,4)
      CALL FRCL(2053,DIFCO,IS,IR)
      CALL IRCL(3010,IVPF,IS,IR)
      CALL IRCL(3014,ITAB,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 2
      IOUT=0
C
C         CALL PKRHI
   23 IDIM=2
      CALL PKRHI(IDIM,CHNLW,VOLI,DENL,VISL,SURT,XLAT,CL,A,B,C,TW,TIME,DI
     1FCO,XMOL,VOL,SIZE,TEMP,SPEVA,TMEND,AREA,IOUT)
      DIAM=2.*SIZE
      IF(DIAM.LE.CHNLW) GO TO 20
      IDIM=1
      CALL PKRHI(IDIM,CHNLW,VOLI,DENL,VISL,SURT,XLAT,CL,A,B,C,TW,TIME,DI
     1FCO,XMOL,VOL,SIZE,TEMP,SPEVA,TMEND,AREA,IOUT)
   20 XCTIM=TMEND+101.
      IF(TIME.LT.XCTIM) GO TO 22
      TIME=TMEND+100.
      GO TO 23
C
C         UPDATE DATA BASE
C
   22 CALL OUTPR(MOD)
      IF(IDIM.NE.2) GO TO 8
      CALL PAGER(1)
      WRITE(LP,11)
    8 IF(IDIM.NE.1) GO TO 9
      CALL PAGER(1)
      WRITE(LP,12)
    9 CALL ISV(2018,IDIM,4)
      CALL FSV(4026,VOL,4)
      CALL FSV(4027,SIZE,4)
      CALL FSV(4028,TEMP,4)
      CALL FSV(4029,SPEVA,4)
      CALL FSV(4030,TMEND,4)
      CALL FSV(4031,AREA,4)
      AVTEM=(TINT+TEMP)/2.
      CALL FSV(4068,AVTEM,4)
      IF(CONC.LT.CFIR) CALL PAGER(3)
      IF(CONC.LT.CFIR) WRITE(LP,200)
      IF(CONC.LT.CFIR) CALL FSV(2033,0.0,6)
C
C     CALCULATE AND SAVE AVERAGE VAPOR EVOLUTION RATE UP TO USER
C     SPECIFIED TIME OR OVER TIME IT TAKES POOL TO COMPLETELY VAPORIZE
C     AND SAVE IT AND THE TIME IN CASE MODEL W FOLLOWS.
C
      TMX=TIME
      IF(TMEND.LT.TMX) TMX=TMEND
      IF(TMX.EQ.TIME) FLOW=(VOLI-VOL)*DENL/TMX
      IF(TMX.EQ.TMEND) FLOW=VOLI*DENL/TMX
      IF(TMX.NE.TIME) GO TO 5
      CALL PAGER(3)
      WRITE(LP,13)
    5 IF(TMX.NE.TMEND) GO TO 6
      CALL PAGER(3)
      WRITE(LP,14)
    6 CALL FSV(4044,FLOW,4)
      CALL FSV(4045,TMX,4)
      IF(TMX.LT.600.) CALL ISV(2061,0,4)
      IF(TMX.GE.600.) CALL ISV(2061,1,4)
      IDM=IDIM
      CALL ENDPR(MOD)
C
C         INTERROGATE USER PLOT REQUEST FLAG
```

```
C
      IF(IVPF.EQ.0.AND.ITAB.EQ.0) GO TO 99
C
C         SET UP LOOP FOR CALCULATION OF PLOT ARRAYS OF VOLUME, SIZE,
C         TEMPERATURE, SPECIFIC EVAPORATION RATE AND AREA OF SPILL
C         VERSUS ELAPSED TIME
C
      DT=.95*TMEND/19.
      IDIM=2
      STM=0.0
      DO 10 I=1,20
      AT(I)=FLOAT(I-1)*DT+(TMEND/20.)
      IF(I.EQ.20) AT(20)=TMEND+100.0
      CALL PKRHI(IDIM,CHNLW,VOLI,DENL,VISL,SURT,XLAT,CL,A,B,C,TW,AT(I),
     1            DIFCO,XMOL,AV(I),AS(I),ATEM(I),AER(I),TMNDE,AR(I),IOUT)
      DIAM=2.*AS(I)
      IF(DIAM.GT.CHNLW.AND.STM.EQ.0.0) STM=AT(I)/60.
      IF(STM.GT.0.0) IDIM=1
      AT(20)=TMEND
   10 CONTINUE
      ATEM(20)=(2.*ATEM(19))-ATEM(18)
      AER(20)=(2.*AER(19))-AER(18)
C
C         WRITE PLOT FILE
      IF(IVPF.EQ.0) GO TO 1
      DO 70 I=1,20
   70 ASAVT(I)=AT(I)/60.
      DO 71 I=1,5
      DO 72 II=1,20
      IF(I.EQ.1) ASAV(II)=AS(II)/100.
      IF(I.EQ.2) ASAV(II)=AV(II)/1000000.0
      IF(I.EQ.3) ASAV(II)=(AER(II)/1000.)*AR(II)
      IF(I.EQ.4) ASAV(II)=AR(II)/10000.
      IF(I.EQ.5) ASAV(II)=ATEM(II)
   72 CONTINUE
      IF(I.EQ.1)
     1CALL PLTLP(PTITL1,ASAVT,ASAV,20,XTITL,YTITL1,1,60.,XTITL1)
      IF(I.EQ.2)
     1CALL PLTLP(PTITL2,ASAVT,ASAV,20,XTITL,YTITL2,1,60.,XTITL1)
      IF(I.EQ.3)
     1CALL PLTLP(PTITL3,ASAVT,ASAV,20,XTITL,YTITL3,1,60.,XTITL1)
      IF(I.EQ.4)
     1CALL PLTLP(PTITL4,ASAVT,ASAV,20,XTITL,YTITL4,1,60.,XTITL1)
      IF(I.EQ.5)
     1CALL PLTLP(PTITL5,ASAVT,ASAV,20,XTITL,YTITL5,1,60.,XTITL1)
      IF(I.NE.1.AND.IDIM.NE.1) GO TO 7
      CALL PAGER(4)
      IF(STM.GT.0.0) WRITE(LP,64) STM
    7 IF(I.NE.4.AND.IDIM.NE.1) GO TO 71
      CALL PAGER(4)
      IF(STM.GT.0.0) WRITE(LP,64) STM
   71 CONTINUE
C
C--------SET UP OFF-LINE PLOT
      PLTYP=1
C
    1 CONTINUE
C
C   WRITE TABLE IF REQUESTED
C
      IF(ITAB.EQ.0) GO TO 99
      CALL PAGER(0)
      CALL PAGER(5)
      WRITE(LP,60)
      CALL PAGER(1)
      WRITE(LP,61)
      CALL PAGER(2)
      WRITE(LP,62)
      SSZ=0.0
      DO 50 I=1,20
      TMNS=AT(I)/60.
      SM=AS(I)/100.
```

```
      SFT=AS(I)/(2.54*12.)
      EVAP=AER(I)*AR(I)/1000.
      AREA=AR(I)/10000.0
      CALL PAGER(1)
      WRITE(LP,63) TMNS,SM,SFT,ATEM(I),EVAP,AREA
   50 CONTINUE
      IF(STM.GT.0.0) CALL PAGER(4)
      IF(STM.GT.0.0) WRITE(LP,64) STM
      GO TO 99
   11 FORMAT(1X,29H THE SPILL POOL IS CIRCULAR. )
   12 FORMAT(1X,46H THE SPILL POOL IS CONFINED BY CHANNEL BANKS. )
   13 FORMAT(/1X,64HTHE VAPOR EVOLUTION RATE AT THE USER SPECIFIED TIME
     1AND THE TIME/1X,34HARE SAVED IN CASE MODEL W FOLLOWS.)
   14 FORMAT(/1X,66HTHE AVERAGE VAPOR EVOLUTION RATE WHILE THE POOL EVAP
     1ORATES AND THE/1X,70HTIME FOR IT TO COMPLETELY EVAPORATE ARE SAVED
     1 IN CASE MODEL W FOLLOWS.)
   21 FORMAT(1X,56HTHE DIFFUSION COEFFICIENT OF VAPOR IN AIR IS CALCULAT
     1ED./1X,46H(VALUE IS DISPLAYED ON STORAGE, THEN RETRIEVAL /
     2 2X,34HTO SHOW USER OVER-RIDE IF PRESENT))
  310 FORMAT (1X,50HTHE LIQUID VOLUME IS COMPUTED AS THE MASS/DENSITY.)
   60 FORMAT(//36X,42HTABLE OF POOL CONDITIONS VS TIME - MODEL V//)
   61 FORMAT(20X,4HTIME,10X,4HSIZE,10X,4HSIZE,10X,4HTEMP,8X,9HEVAP RATE,
     17X,4HAREA)
   62 FORMAT(19X,6H(MINS),10X,3H(M),10X,4H(FT),9X,7H(DEG C),7X,8H(KG/SEC
     1),6X,6H(M**2)/)
   63 FORMAT(19X,G10.4,5(4X,G10.4))
   64 FORMAT(//17X,44HNOTE - DURING THE TIME INTERVAL BEFORE TIME=,G10.4
     1,6H MINS,/17X,38HTHE POOL IS CONFINED BY CHANNEL BANKS.)
  100 FORMAT(96H WARNING- THE LIQUID DENSITY OF THE SPILLED CHEMICAL IS
     *SO CLOSE TO WATER THAT IT MAY OR MAY NOT/77H FLOAT. FOR MODEL V IT
     * WILL BE ASSUMED THAT IT HAS A DENSITY OF 0.99 GM/CM**3//)
  200 FORMAT(72H NOTE-VAPOR PRESSURE OF LIQUID IS TOO LOW TO FORM FLAMMA
     1BLE VAPOR CLOUD./ 53H LOWER FLAMMABLE LIMIT SET TO ZERO BEFORE PRO
     2CEEDING./)
   99 CALL TRACE(1,8,5)
      END
      SUBROUTINE FCT(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,DEL,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,A)
C *** THIS SUBROUTINE IS CALLED BY THE RKGS SUBROUTINE FOR THE EVALUATIO
C *** OF THE RIGHT HAND SIDE OF THE SYSTEM OF THE DIFFERENTIAL EQUATIONS
C *** IN THIS CASE THE RHS FUNCTIONS ARE THE ONES THAT GIVE THE TEMPERAT
C *** DECREASE RATE AND THE MASS DECREASE RATE FOR THE HIGH VAPOR PRESSU
C *** LIQUID SPILL
C
      DIMENSION Y(5),DERY(5)
      PI=3.141592653
      ETA=EXP(-BETA*(1./Y(1)-1./THETW))
      TIME=X*TIMEC
C ***  OBTAINING THE AREA OF THE POOL FROM SPREAD MODELS ***
      CALL RLJSP(IDIM,VOLI,DENL,VISL,SURT,TIME,CHNLW,SIZE)
       GO TO (5,10),IDIM
C ***  A IS THE NON DIMENSIONAL AREA ---NON DIMENSIONLISED WITH RESPECT
C ***  THE INITIAL CHARACTERISTIC AREA -AI--.
    5 A=SIZE*CHNLW/AI
C  ***  C IS THE CORRECTION FACTOR WHICH TAKES INTO ACCOUNT THE NON UNIF
C  ***  THERMAL BOUNDARY LAYER THICKNESS IN WATER DURING THE SPREADING.
      C=PI/2.
      GO TO 15
   10 A=PI*SIZE**2/AI
      C=2.
C ***  DERIVATIVE FUNCTIONS ***
   15 IF(X)16,16,17
   16 DERY(1)=-A*ETA
      GO TO 18
17    DERY(1)=A*(DEL*C*(THETW-Y(1))/SQRT(X)-ETA)/Y(2)
   18 DERY(2)=-A*ETA
      RETURN
      END
      SUBROUTINE OUTP(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,AUX,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,A    ,IHLF,NDIM,PMRT,IOUT,IHEAD)
C ***  THIS IS AN OUTPUT SUBROUTINE CALLED BY THE RKGS SUBROUTINE.
C ***  THIS ROUTINE IS USED HERE TO WRITE THE CALCULATED VALUES OF THE
```

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C ***  EVAPORATION RATE,MASS REMAINING ETC AT EVERY INSTANT OF TIME.
C ***  X,Y,DERY ARE ALL IN NON DIMENSIONA UNITS. THE OUTPUT VALUES ARE I
C ***  IONAL UNITS
C *******************************************************************
C ***  TIME    AT WHICH THE ANSWERS ARE WRITTEN                SECS
C ***  TEMP    TEMPERATURE OF THE LIQUID AT THE TIME INDICATED   DEG C
C ***  FRMAS   FRACTION OF THE INITIAL MAAS REMAINING IN THE SYSTEM
C ***  ZMAS    MASS REMAINING IN THE SYSTEM                 GMS
C ***  AREA    AREA OF THE POOL OF SPREAD AT  THE KTIME INDICATED       C
C ***  SPEVA   SPECIFIC EVAPORATION. THAT IS THE EVAPORATION IN GMS/SEC
C ***  IOUT    A FLAG WHICH INDICATES IF THE OUTP ROUTINE IS TO EXECUTED
C ***  IHEAD   A FLAG WHICH INDICATES IF THE HEADING IS TO BE WRITTEN OR
C *******************************************************************
C
      DIMENSION AUX(8, 2),Y(5),DERY(5),PMRT(5)
      LP=6
C     IF\AUX\5,2'' 10,10,30              CHANGED TO CARD BELOW  04/24/73
      IF (Y(2)) 10,30,30
10    PMRT(5)=5.
20    RETURN
30    IF(IOUT) 20,20,40
40    IF(IHEAD) 70,70,60
   60 CALL PAGER(3)
      WRITE(LP,200)
70    PI=3.141592653
      TIME=X*TIMEC
      TEMP=Y(1)*TEMPS-273.
      FRMAS=Y(2)
      ZMAS=ZMI*FRMAS
      AREA=A*AI
      SPEVA=0.
      IF(A) 90,90,80
80    SPEVA=-ZMI*DERY(2)/(TIMEC*AREA)
   90 CALL PAGER(1)
      WRITE(LP,100) TIME,FRMAS,ZMAS,SPEVA,AREA,IHLF
      RETURN
100   FORMAT(2X,E14.5, 2X,     2(E14.5,4X),2X,E14.5,8X,E14.5,4X,I2)
  200 FORMAT(6X,4HTIME,12X,11HFRACTN MASS,6X,14HREMAINING MASS,6X,14HSPE
     1CIFIC EVAPN,9X,9HPOOL AREA/6X,4HSECS,33X,5HGRAMS,13X,12HGM/SEC-CM*
     2*2,13X,5HSQ CM//)
      END
      SUBROUTINE PKRHI(IDIM,CHNLW,VOLI,DENL,VISL,SURT,XLAT,CL,A,B,C,TW,
     1TIME,DIFCO,XMOL,VOL,SIZE,TEMP,SPEVA,TMEND,AREA,IOUT)
C  ******************************************************************
C *** THIS SUBROUTINE CALCULATES THE CONDITIONS AFTER THE SPILL OF A HIG
C ***  VAPOR PRESSURE LIQUID ON WATER.  FOR A GIVEN SPILL VOLUME AND TEM
C ***  THE SUBROUTINE RETURNS THE SIZEOF SPREAD,THE VOLUME REMAINING,
C ***  AND THE EVAPORATION RATE OF THE LIQUID.  THE CLAUSIUS CLAYPERON
C ***  EQUATION FOR SATURATED VAPOR PRESSURE IS UTILIZED.
C
C ************ A R G U M E N T   D E S C R I P T I O N ****************
C *****   INPUT VALUES *************
C      IDIM    DIMENSION OF THE SPREAD   1-DIMENSIONAL=1   RADIAL=2
C      CHNLW   CHANNEL WIDTH      CM
C      VOLI    INITIAL VOLUME     CUBIC CM
C      DENL    DENSITY OF THE SPILLED LIQUID      G/CC
C      VISL    VISCOSITY OF THE SPILLED LIQUID      DYNE-SEC/CM
C      SURT    SURFACE TENSION OF THE SPILLED LIQUID      DYNES/CM
C      XLAT    HEAT OF VAPORIZATION OF THE SPILLED LIQUID      CAL/GM
C      CL      SPECIFIC HEAT OF THE SPILLED LIQUID    CAL/GM-DEGREE K
C      A,B,C   CONSTANTS IN THE SATURATED VAPOR PRESSURE EQUATION
C              P=10.**(A-(B/(T+C)))
C      TW      TEMPERATURE OF WATER    DEGREES C
C      TIME    TIME AT WHICH THE CONDITIONS ARE TO BE KNOWN      SEC
C      DIFCO   DIFFUSION COEFFICIENT OF VAPOR IN AIR     SQ CM/SEC
C      XMOL    MOLECULAR WEIGHT OF SPILLED COMPOUND      GM/MOL
C
C *****   OUTPUT VALUES ****
C      TMEND   TIME AT WHICH PROGRAM STOPS - SPECIFIED TIME OR TIME AT WH
C              ALL LIQUID HAS EVAPORATED - WHICHEVER COMES FIRST     SEC
C       VOL    VOLUME OF THE LIQUID REMAINING AT TMEND
C      SIZE    SIZE OF THE SPILL AT TMEND (RADIUS OR LENGTH)          CMS
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C     SPEVA   SPECIFIC EVAPORATION RATE AT TMEND                  GM/SEC C
C     AREA    AREA OF THE SPILL AT TMEND            SQUARE CM
C
C *****   INPUT/OUTPUT VALUES ****
C     IOUT    1 IF WANT INTERMEDIATE VALUES OF VOL, SIZE, TEMP
C             0 IF ONLY WANT FINAL VALUES
C             VALUE MAY BE CHANGED WITHIN SUBROUTINE CALLED BY THIS ONE
C  *********************************************************************
C
      EXTERNAL OUTP, FCT
      DIMENSION PMRT(5),Y(5),AUX(8,2 ),DERY(5)
      FACT=10.
      NSEC=50
      CALL       HMTC(DIFCO,XMOL,VOLI,HMP)
      DENW=1.0
      CONDW=.0013
      PI=3.141592653
C   **** CALCULATION OF CHARACTERISTIC AND NON DIMENSIONALING PARAMETERS
      ALFW=CONDW/DENW
      ZMI=VOLI*DENL
      AI=FACT*VOLI**0.666667
      TEMPS=XLAT/CL
      PVAPI=(10.**(A-(B/(TW+C))))/760.
      EIDOT=HMP*PVAPI
      TIMEC=ZMI/(AI*EIDOT)
      TOWEN=TIME/TIMEC
      DEL=CONDW*TEMPS/(EIDOT*XLAT*SQRT(PI*ALFW*TIMEC))
      BETA=B/TEMPS
      THETW=(TW+273.)/TEMPS
C  *** INTEGRATION OF THE SIMULTANEOUS SYSTEM OF DIFFERENTIAL EQUATIONS
C  *** Y(1) IS THE TEMPERATURE  AND Y(2) IS THE MASS OF THE LIQUID ***
C  *** FIRST THE INITIAL CONDITIONS AND ERROR WEIGHTS ARE GIVEN ***
2000  Y(1)=THETW
      Y(2)=1.
      NDIM=2
      PMRT(1)=0.
      PMRT(2)=TOWEN
      PMRT(3)=TOWEN/FLOAT(NSEC)
      PMRT(4)=.005
      DERY(1)=0.5
      DERY(2)=0.5
      CALL       PKRRK(PMRT,Y,DERY,NDIM,IHLF,FCT,OUTP,AUX,AI,ZMI,TEMPS,
     1TIMEC,DEL,BETA,THETW,IDIM,CHNLW,VOLI,DENL,VISL,SURT,SIZE,S,IOUT,X)
      FRMAS=AUX(1,2)
      ZMAS=ZMI*FRMAS
      VOL=ZMAS/DENL
      TEMP=AUX(1,1)*TEMPS-273.
      AREA=S*AI
      SPEVA=0.
      IF(S) 90,90,80
80    SPEVA=-ZMI*AUX(2,2)/(TIMEC*AREA)
90    TMEND=X*TIMEC
      RETURN
      END
      SUBROUTINE PKRRK(PRMT,Y,DERY,NDIM,IHLF,FCT,OUTP,AUX,AI,ZMI,TEMPS,
     1TIMEC,DEL,BETA,THETW,IDIM,CHNLW,VOLI,DENL,VISL,SURT,SIZE,S,IOUT,X)
C
      EXTERNAL FCT ,OUTP
      DIMENSION Y(5),DERY(5),AUX(8, 2),A(4),B(4),C(4),PRMT(5)
      DO 1 I=1,NDIM
    1 AUX(8,I)=.06666667*DERY(I)
      X=PRMT(1)
      XEND=PRMT(2)
      H=PRMT(3)
      PRMT(5)=0.
      CALL       FCT(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,DEL,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,S)
C     ERROR TEST
      IF(H*(XEND-X))38,37,2
C     PREPARATIONS FOR RUNGE-KUTTA METHOD
    2 A(1)=.5
      A(2)=.2928932
```

```
      A(3)=1.707107
      A(4)=.1666667
      B(1)=2.
      B(2)=1.
      B(3)=1.
      B(4)=2.
      C(1)=.5
      C(2)=.2928932
      C(3)=1.707107
      C(4)=.5
C     PREPARATIONS OF FIRST RUNGE-KUTTA STEP
      DO 3 I=1,NDIM
      AUX(1,I)=Y(I)
      AUX(2,I)=DERY(I)
      AUX(3,I)=0.
    3 AUX(6,I)=0.
      IREC=0
      H=H+H
      IHLF=-1
      ISTEP=0
      IEND=0
C     RECORDING OF INITIAL VALUES OF THIS STEP
      IHEAD=1
      CALL        OUTP(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,AUX,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,S    ,IREC,NDIM,PRMT,IOUT,IHEAD)
      IHEAD=0
C     START OF A RUNGE-KUTTA STEP
    4 IF((X+H-XEND)*H)7,6,5
    5 H=XEND-X
    6 IEND=1
7     CONTINUE
      IF(PRMT(5))40,8,40
    8 ITEST=0
    9 ISTEP=ISTEP+1
C     START OF INNERMOST RUNGE-KUTTA LOOP
      J=1
   10 AJ=A(J)
      BJ=B(J)
      CJ=C(J)
      DO 11 I=1,NDIM
      R1=H*DERY(I)
      R2=AJ*(R1-BJ*AUX(6,I))
      Y(I)=Y(I)+R2
      R2=R2+R2+R2
   11 AUX(6,I)=AUX(6,I)+R2-CJ*R1
      IF(J-4)12,15,15
   12 J=J+1
      IF(J-3)13,14,13
   13 X=X+.5*H
   14 CALL        FCT(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,DEL,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,S)
      GOTO 10
C     END OF INNERMOST RUNGE-KUTTA LOOP
C     TEST OF ACCURACY
   15 IF(ITEST)16,16,20
C     IN CASE ITEST=0 THERE IS NO POSSIBILITY FOR TESTING OF ACCURACY
   16 DO 17 I=1,NDIM
   17 AUX(4,I)=Y(I)
      ITEST=1
      ISTEP=ISTEP+ISTEP-2
   18 IHLF=IHLF+1
      X=X-H
      H=.5*H
      DO 19 I=1,NDIM
      Y(I)=AUX(1,I)
      DERY(I)=AUX(2,I)
   19 AUX(6,I)=AUX(3,I)
      GOTO 9
C     IN CASE ITEST=1 TESTING OF ACCURACY IS POSSIBLE
   20 IMOD=ISTEP/2
      IF(ISTEP-IMOD-IMOD)21,23,21
   21 CALL        FCT(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,DEL,BETA,THETW,IDIM,
```

```
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,S)
      DO 22 I=1,NDIM
      AUX(5,I)=Y(I)
   22 AUX(7,I)=DERY(I)
      GOTO 9
C     COMPUTATION OF TEST VALUE DELT
   23 DELT=0.
      DO 24 I=1,NDIM
   24 DELT=DELT+AUX(8,I)*ABS(AUX(4,I)-Y(I))
      IF(DELT-PRMT(4))28,28,25
C     ERROR IS TOO GREAT
   25 IF(IHLF-10)26,36,36
   26 DO 27 I=1,NDIM
   27 AUX(4,I)=AUX(5,I)
      ISTEP=ISTEP+ISTEP-4
      X=X-H
      IEND=0
      GOTO 18
C     RESULT VALUES ARE GOOD
   28 CALL        FCT(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,DEL,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,S)
      CALL        OUTP(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,AUX,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,S    ,IREC,NDIM,PRMT,IOUT,IHEAD)
C *** CHECK IS MADE IF THE NEXT MASS VALUE IS NEGATIVE. IF SO CALCULATI
C *** IS STOPPED BY GOINT TO LINE 50.
      ISKIP=PRMT(5)/2.
      IF(ISKIP-2) 55,50,55
   55 DO 29 I=1,NDIM
      AUX(1,I)=Y(I)
      AUX(2,I)=DERY(I)
      AUX(3,I)=AUX(6,I)
      Y(I)=AUX(5,I)
   29 DERY(I)=AUX(7,I)
      IF(PRMT(5))40,30,40
   30 DO 31 I=1,NDIM
      Y(I)=AUX(1,I)
   31 DERY(I)=AUX(2,I)
      IREC=IHLF
      IF(IEND)32,32,39
C     INCREMENT GETS DOUBLED
   32 IHLF=IHLF-1
      ISTEP=ISTEP/2
      H=H+H
      IF(IHLF)4,33,33
   33 IMOD=ISTEP/2
      IF(ISTEP-IMOD-IMOD)4,34,4
   34 IF(DELT-.02*PRMT(4))35,35,4
   35 IHLF=IHLF-1
      ISTEP=ISTEP/2
      H=H+H
      GOTO 4
C     RETURNS TO CALLING PROGRAM
   36 IHLF=11
      CALL        FCT(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,DEL,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,S)
      GOTO 39
   37 IHLF=12
      GOTO 39
   38 IHLF=13
   39 CALL        OUTP(X,Y,DERY,AI,ZMI,TEMPS,TIMEC,AUX,BETA,THETW,IDIM,
     1CHNLW,VOLI,DENL,VISL,SURT,SIZE,S    ,IREC,NDIM,PRMT,IOUT,IHEAD)
   40 RETURN
C *** DIFM AND DIFT ARE THE AVERAGE VALUES OF THE RATE OF CHANGE OF MAS
C *** RATE OF CHANGE OF TEMPERATURE,RESPECTIVELY BETWEEN THE LAST STEP
C *** AND THE TIME AT WHICH THE MASS GOES NEGATIVE.
   50 DIFM=(AUX(2,2)+DERY(2))/2.
      DIFT=(AUX(2,1)+DERY(1))/2.
C *** DX IS THE TIME BETWEEN THE LAST TIME AND THE TIME AT WHICH THE MA
C *** GOES TO ZERO
      DX=(0.-AUX(1,2))/DIFM
      X=X+DX
      AUX(1,2)=0.
```

```
      AUX(1,1)=AUX(1,1)+DIFT*DX
      RETURN
      END
      OVERLAY(10,6)
      PROGRAM MODX
C
C
C        PROGRAM EXECUTES MODEL X, INDEX 24
C
C
C     MODX CALCULATES THE CONDITIONS FOLLOWING A SPILL OF A  HEAVIER-
C     THAN-WATER,SLIGHTLY SOLUBLE CHEMICAL WITH A BOILING POINT GREATER
C     THAN THE AMBIENT TEMPERATURE.  SEE ROUTINES SINK1,SINK2, AND
C     SINK3 FOR SPECIFIC CAPABILITIES.
C
      COMMON/C/PLTYP,XBX(150)
      INTEGER  PLTYP
      EQUIVALENCE (XBX(1),XD(1))
      EQUIVALENCE (XBX(21),CNC(1,1))
      EQUIVALENCE (XBX(61),CRTM(1,1))
      DIMENSION XD(20),CNC(2,20),CRTM(2,20)
      DATA MOD/4H  X /
    1 CONTINUE
C
      CALL TRACE(0,8,6)
      LP=6
      IS=6
      IR=0
C
C        OBTAIN DATA
C
      CALL BEGPR(MOD)
      CALL FRCL(1002,AM,IS,IR)
      CALL FRCL(1003,TBOIL,IS,IR)
      CALL FRCL(1004,DENL,IS,IR)
      IF(DENL - 1.) 10,10,20
   10 CALL PAGER(6)
      WRITE(6,100)
      DENL=1.01
   20 CONTINUE
      CALL FRCL(1021,DLB,IS,IR)
      CALL FRCL(1025,TCRIT,IS,IR)
      CALL FRCL(1031,SURT,IS,IR)
      CALL FRCL(2021,DS,IS,IR)
      CALL FRCL(2023,TWAT,IS,IR)
      CALL FRCL(2039,X,IS,IR)
      CALL FRCL(2040,Y,IS,IR)
      CALL FRCL(2041,Z,IS,IR)
      CALL FRCL(2044,DW,IS,IR)
      CALL FRCL(2045,WW,IS,IR)
      CALL FRCL(2047,US,IS,IR)
      CALL FRCL(2052,XN,IS,IR)
      CALL FRCL(4002,SPAMT,IS,IR)
C
C     CALL ROUTINE SOLUB TO FIND SOLUBILITY OF CHEMICAL AT THE
C     WATER TEMPERATURE
C     SOLUB CALLS DATA OF FIELD NUMBERS 1026,1028, AND1029
C
      CALL SOLUB(TWAT,CSAT,IS,IR)
      CSAT=CSAT/100.
C
C     CALCULATE DIFFUSION COEFF OF CHEMICAL IN WATER
C
      CALL CDIFW(AM,DLB,TWAT,TCRIT,TBOIL,DIFW)
      CALL FSV(2043,DIFW,4)
      CALL FRCL(2043,DIFW,IS,IR)
C
      CALL IRCL(3012,ITX,IS,IR)
      IF(ITX.GE.1) CALL FRCL(2031,XMX,IS,IR)
      CALL EPRNT(MOD,IS,IR,IL)
      IF(IL.EQ.1) GO TO 99
      IF(IL.EQ.2) GO TO 1
```

```
C
C         CALL SINK
      CALL SINK1(SURT,DW,US,SPAMT,DENL,XN,DS,TIME,DIST,AREA,PLEN,TMSPR)
      CALL SINK2(DIFW,US,PLEN,AREA,CSAT,SPAMT,DW,DISRT,DISTM)
      CALL SINK3(WW,DW,X,Y,Z,US,DIST,TIME,DISRT,DISTM,XN,AREA,PLEN,CONC,
     1CLRTM,IFLAG)
C
C         UPDATE DATA BASE
C
      CALL OUTPR(MOD)
      CALL FSV(4032,TIME,4)
      CALL FSV(4033,DIST,4)
      CALL FSV(4036,DISRT,4)
      CALL FSV(4037,DISTM,4)
      CALL FSV(4038,AREA,4)
      CALL FSV(4039,PLEN,4)
      CALL FSV(4040,TMSPR,4)
      CALL FSV(4041,CLRTM,4)
      IF(CONC.GT.DENL) CONC=DENL
      CALL FSV(4042,CONC,4)
      CMGL=CONC*1000000.0
      CPPM=CMGL/DENL
      CALL PAGER(2)
      WRITE(LP,52) CPPM,CMGL
      IF(IFLAG.NE.1) GO TO 75
      CALL PAGER(4)
      WRITE(6,50)
      CALL PAGER(1)
      WRITE(LP,51)
      CALL FSV(2039,X,6)
   75 CONTINUE
      CALL ENDPR(MOD)
      IF(ITX.EQ.0) GO TO 99
C
C     CALCULATE DATA FOR MAX CONCENTRATIONS AT RIVER BOTTOM AND SURFACE
C     VS DISTANCE DOWNSTREAM
C
      CALL PAGER(0)
      CALL PAGER(9)
      WRITE(6,30)
      WRITE(6,31)
      WRITE(6,40)
      WRITE(6,41)
      Y=0.0
      Z=0.0
      XMN=DIST+PLEN+(10.*2.54*12.)
C
C     SET MAX DIST TO 5 TIMES MIN ALLOWED IF USER SUPPLIES UNREASONABLE
C     INPUT
C
      IF(XMX.LE.XMN) XMX=5.*XMN
      DX=(XMX-XMN)/19.
      DO 90 II=1,2
      DO 80 I=1,20
      JJJJ=I
      XD(I)=XMN+((FLOAT(JJJJ)-1.)*DX)
      CALL SINK3(WW,DW,XD(I),Y,Z,US,DIST,TIME,DISRT,DISTM,XN,AREA,PLEN,
     1CNC(II,I),CRTM(II,I),IFLAG)
      IF(CNC(II,I).GT.DENL) CNC(II,I)=DENL
      XDIS=XD(I)/(2.54*12.)
      XD(I)=XD(I)/100.
      CONC=CNC(II,I)*1000000.
      CNC(II,I)=CONC/DENL
      TMS=CRTM(II,I)/60.
      THR=CRTM(II,I)/3600.
      CALL PAGER(1)
      WRITE(LP,70) XD(I),XDIS,CONC,CNC(II,I),TMS,THR
   80 CONTINUE
      IF(II.EQ.2) GO TO 99
      CALL PAGER(0)
      CALL PAGER(9)
      WRITE(6,30)
```

```
      WRITE(6,32)
      WRITE(6,40)
      WRITE(6,41)
      Z=DW
   90 CONTINUE
      GO TO 99
   30 FORMAT (/12X,42HTABLE OF MAXIMUM CONCENTRATION VS DISTANCE)
   31 FORMAT(20X,26HAT WATER SURFACE - MODEL X//)
   32 FORMAT(20X,25HAT WATER BOTTOM - MODEL X//)
   40 FORMAT(3X,8HDISTANCE,4X,8HDISTANCE,6X,4HCONC,8X,4HCONC,6X,8HCLR TI
     1ME,4X,8HCLR TIME)
   41 FORMAT(6X,3H(M),8X,4H(FT),5X,10H(MG/LITER),5X,5H(PPM),6X,6H(MINS),
     17X,5H(HRS)//)
   50 FORMAT(/40H NOTE-USER INPUT FOR X WAS UNREASONABLE./ 1X,43HIT WAS
     *CHANGED AS NOTED IN THE HACS MANUAL./)
   51 FORMAT(1X,19HTHE NEW X VALUE IS-)
   52 FORMAT(/1X,35HTHIS CONCENTRATION IS EQUIVALENT TO,G10.4,1X,7HPPM A
     1ND,G10.4,1X,9HMG/LITER.)
   70 FORMAT(2X,G10.4,2X,G10.4,2X,G10.4,2X,G10.4,2X,G10.4,2X,G10.4)
  100 FORMAT(/70H WARNING - THE CHEMICAL WHICH HAS BEEN DISCHARGED HAS A
     * LIQUID DENSITY/68H SO CLOSE TO WATER THAT IT MAY OR MAY NOT SINK.
     * FOR MODEL X, IT WILL/50H BE ASSUMED THAT IT HAS A DENSITY OF 1.01
     * GM/CM**//)
   99 CONTINUE
      CALL TRACE(1,8,6)
      END
      SUBROUTINE SINK1(SURT,DW,US,SPAMT,DENL,XN,DS,TIME,DIST,AREA,PLEN,
     *TMSPR)
C
C***********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE TIME TO SINK, DISTANCE TRAVELED
C     DOWNSTREAM BEFORE REACHING RIVER BOTTOM,AREA OF RIVERBED COVERED,
C     LENGTH OF CHEMICAL POOL ON RIVERBED, AND TIME FOR POOL TO SPREAD
C     TO ITS MAXIMUM EXTENT FOR A HEAVIER-THAN-WATER , SLIGHTLY SOLUBLE
C     CHEMICAL WITH A BOILING POINT GREATER THAN THE AMBIENT
C     TEMPERATURE SPILLED INTO A NON-TIDAL RIVER.
C
C                    *****INPUTS*****
C
C     SURT = INTERFACIAL TENSION OF SPILLED CHEMICAL          DYNE/CM
C     DW   = DEPTH OF RIVER                                   CMS
C     US   = MEAN STREAM VELOCITY                             CM/SEC
C     SPAMT= AMOUNT OF CHEMICAL SPILLED                       GMS
C     DENL = DENSITY OF LIQUID SPILLED                        GM/CM3
C     XN   = MANNING ROUGHNESS FACTOR FOR RIVER               NON-DIM
C     DS   = DISTANCE FROM SURFACE WHERE RELEASE TAKES PLACE
C            DS=0.0 AT SURFACE, DS=DW AT BOTTOM              CMS
C
C                    *****OUTPUTS*****
C
C     TIME = TIME FOR CHEMICAL TO SINK TO RIVERBED            SECS
C     DIST = DISTANCE CHEMICAL TRAVELS DOWNSTREAM BEFORE
C            REACHING RIVERBED                                CMS
C     AREA = AREA OF RIVERBED COVERED BY CHEMICAL             CM**2
C     PLEN = LENGTH OF CHEMICAL POOL ON RIVERBED              CM
C     TMSPR= TIME FOR POOL TO SPREAD TO ITS MAXIMUM EXTENT    SECS
C
C                   *****OTHER PARAMETERS*****
C     WC   = CRITICAL WEBER NUMBER AT WHICH THE LIQUID
C            BREAKS UP. (8)WC)10)
C     CD   = DRAG COEFFICIENT DURING THE DECENT OF THE
C            DROP IN WATER.
C     GRAV = EFFECTIVE GRAVITY (G*(DENL/DENW-1.))             CM/SEC2
C     GR   = GRAVITATIONAL ACCELERATION                       CM/SEC2
C     PRW  = PRANDTT NUMBER FOR WATER.
C
C***********************************************************************
C
      PI=3.141592654
      A=1.778
      GR=980.
```

```
      WC=10.
      CD=0.4
      DENW=1.0
C
C     CALCULATE TIME TO SINK AND DISTANCE TRAVELED
C
      DELRO=DENL-DENW
      GEFF=GR*(DENL/DENW-1.)
      DEL=0.056*WC
      F=SQRT((1.-DEL)*((1.+A*(1.-DEL)**1.5)/(1.+A)))
      RO=SQRT((3./8.)*(WC*CD/F**2)*(SURT/(GR*DELRO)))
      UO=F*SQRT((8./3.)*(GEFF/CD)*RO)
      TIME=(DW-DS)/UO
      DIST=TIME*US
C
C     CALCULATE AREA,LENGTH,AND SPREAD TIME OF POOL
C
      GRAV=GR*(1.-DENW/DENL)
      VOL=SPAMT/DENL
      E=(1./12.)*(10.**(3.18173-8.571E-2/XN))
      FD=US/SQRT(GRAV*DW)
      CRITH=0.9783*DW*(FD**2.8)
      CRITR=0.5704*SQRT(VOL/DW)/FD**1.4
      CRITA=PI*CRITR**2
      CRITT=(0.2504/FD**2.8)*SQRT(VOL/(GRAV*DW*DW))
      UC=(8./7.)*(E/DW)**(1./7.)
      UGHFC=1.152*SQRT(GRAV*CRITH)
      USHF=(8./7.)*US*(E/DW)**(1./7.)
      IF(CRITH.GT.E) GO TO 3
      RAD=SQRT(VOL/(E*PI))
      PLEN=2.*RAD
      AREA=PI*RAD**2
      TMSPR=RAD**2/((1.14**2)*SQRT(GRAV*VOL))
      RETURN
    3 AREA=VOL/E
      HC=CRITH/DW
      HF=E/DW
      UBAR=US*(HC**(8./7.)-HF**(8./7.))/(HC-HF)
      V=UBAR/UC
      ALFAF=AREA/CRITA
      AL=ALFAF**1.5
      DTOW=0.005
    4 TOW=TOW+DTOW
      Z=(1.+V*TOW)**1.5
      RHS=(6./V)*(Z**(4./3.)-Z)+Z
      IF(RHS.LT.AL) GO TO 4
      TMSPR=CRITT+TOW*2.*CRITR/UC
      PLEN=2.*CRITR*(1.+V*TOW)
      RETURN
      END
      SUBROUTINE SINK2(DIFW,US,PLEN,AREA,CSAT,SPAMT,DW,DISRT,DISTM)
C
C**********************************************************************
C
C     THIS ROUTINE, USING THE LENGTH AND AREA OF THE CHEMICAL POOL
C     FROM ROUTINE SINK1 CALCULATES THE DISSOLUTION RATE OF THE
C     SPILL POOL INTO WATER AND THE TIME IT TAKES ALL THE CHEMICAL
C     TO DISSOLVE.
C
C                    *****INPUTS*****
C
C     DIFW = DIFFUSION COEFFICIENT OF LIQUID IN WATER           CM2/SEC
C     US   = MEAN STREAM VELOCITY                               CM/SEC
C     PLEN = LENGTH OF CHEMICAL POOL ON RIVERBED                CM
C     AREA = AREA OF RIVERBED COVERED BY CHEMICAL               CM**2
C     CSAT = SOLUBILITY OF THE CHEMICAL IN WATER                GM/GM
C     SPAMT= AMOUNT OF CHEMICAL SPILLED                         GMS
C     DW   = DEPTH OF RIVER                                     CMS
C
C                    *****OUTPUTS*****
C
C     DISRT= AVERAGE DISSOLUTION RATE OF CHEMICAL POOL          GM/SEC
```

```
C      DISTM= TIME FOR ALL CHEMICAL TO DISSOLVE                      SECS
C
C         ***** OTHER PARAMETERS *****
C      S     = SHAPE FACTOR-DEPENDS ON THE SHAPE OF THE LIQUID
C              POOL-MEAN VALUE OF SEVERAL STANDARD GEOMETRICAL
C              SHAPES=1.076
C      SC    = SCHMIDT NUMBER=KINEMATIC VISCOSITY OF WATER/
C              DIFFUSIVITY OF LIQUID IN WATER
C      REL   = REYNOLDS NUMBER FOR THE STREAM FLOW BASED ON
C              POOL LENGTH, AND MEAN STREAM VELOCITY.
C
C************************************************************************
C
       DATA DENW,VISKW,S/1.0,0.01,1.076/
C
C      CALCULATE DISSOLUTION RATE OF LIQUID POOL
C
       SC=VISKW/DIFW
       REL=US*PLEN/VISKW
       W=AREA/PLEN
       DISRT=S*0.0343*DENW*CSAT*DIFW*W*(SC**(11./27.))*(REL**(7./9.))
      1*((PLEN/DW)**(1./9.))
       DISTM=SPAMT/DISRT
       RETURN
       END
       SUBROUTINE SINK3(WW,DW,X,Y,Z,US,DIST,TIME,DISRT,DISTM,XN,AREA,PLEN
      1,CONC,CLRTM,IFLAG)
C************************************************************************
C
C      THIS SUBROUTINE GIVES THE DOWN STREAM CONCENTRATION
C      OF A CHEMICAL DISSOLVING SLOWLY INTO THE WATER
C      FROM A LIQUID POOL ON THE RIVER BED.  THE DISPERSION
C      CALCULATIONS ARE PERFORMED BY ASSUMING A LINE
C      SOURCE AT THE DOWNSTREAM EDGE OF THE LIQUID POOL.
C
C                    *****INPUTS*****
C
C      WW    = WIDTH OF RIVER                                          CMS
C      DW    = DEPTH OF RIVER                                          CMS
C      X     = DOWNSTREAM DISTANCE FROM SPILL SITE AT WHICH
C              CHEMICAL CONCENTRATION IS DESIRED                       CMS
C      Y     = DISTANCE FROM MIDSTREAM WHERE CONCENTRATION DESIRED CMS
C      Z     = DEPTH IN RIVER WHERE CONCENTRATION IS DESIRED           CMS
C      US    = MEAN STREAM VELOCITY                                    CM/SEC
C      DIST  = DISTANCE CHEMICAL TRAVELS DOWNSTREAM BEFORE
C              REACHING RIVERBED                                       CMS
C      TIME  = TIME FOR CHEMICAL TO SINK TO RIVERBED                   SECS
C      DISRT= AVERAGE DISSOLUTION RATE OF CHEMICAL POOL                GM/SEC
C      DISTM= TIME FOR ALL CHEMICAL TO DISSOLVE                        SECS
C      XN    = MANNING ROUGHNESS FACTOR FOR RIVER                      NON-DIM
C      AREA  = AREA OF RIVERBED COVERED BY CHEMICAL                    CM**2
C      PLEN  = LENGTH OF CHEMICAL POOL ON RIVERBED                     CM
C
C                    *****OUTPUTS*****
C
C      CONC  = CONCENTRATION OF CHEMICAL AT DOWNSTREAM
C              POINT SPECIFIED                                         GM/CM3
C      CLRTM= TIME AFTER SPILL AT WHICH POLLUTANTS
C              WILL HAVE PASSED DOWNSTREAM POINT SPECIFIED             SECS
C      IFLAG= FLAG INDICATING WHETHER X DISTANCE INPUT WAS
C              RETURNED MODIFIED OR UNCHANGED. IFLAG=0 MEANS
C              IT WAS UNCHANGED. IFLAG=1 MEANS THE DISTANCE
C              INPUT WAS BEHIND OR WITHIN THE SPILL POOL AND
C              THE DISTANCE WAS CHANGED TO X=DIST+PLEN+X               NON-DIM
C
C************************************************************************
C
C      CALCULATE DISPERSION COEFFICIENTS FOR NON TIDAL RIVER
C
       PI=3.141592654
       DENW=1.0
       W=AREA/PLEN
```

```
      RH=WW*DW/(2.*DW+WW)
      USTAR=6.7305*XN*US/RH**(1./6.)
      EZ=0.067*USTAR*RH
      EX=0.1*EZ
      IF(WW/DW-100.) 10,5,5
    5 EY=0.1*EZ
      GO TO 15
   10 EY=0.23*USTAR*RH
   15 XD=X-(DIST+PLEN)
      IF(XD.LE.0.0) IFLAG=1
      IF(IFLAG.EQ.1) XD=X
      IF(IFLAG.EQ.1) X=XD+DIST+PLEN
C
C     ABOVE MANIPULATION PREVENTS UNREASONABLE X DISTANCE INPUT
C
C     DETERMINE WHETHER NEAR- OR FAR-FIELD CONCENTRATION MODEL IS USED
C
      XCRIT=((WW/W)**2.)*(US*DW/EZ)*DW
      IF(XD-XCRIT) 20,20,25
C
C     CALCULATE WATER CONCENTRATION USING NEAR-STREAM MODEL
C
   20 SZ=SQRT(4.*XD*EZ/US)
      SY=SQRT(4.*XD*EY/US)
      DOTM=DISRT/W
      CMAX=DOTM/(2.*SQRT(PI*US*XD*EZ))
      B=W/2.
      ESP=ERF((Y-WW+B)/SY)-ERF((Y-WW-B)/SY)+ERF((Y+WW+B)/SY)-ERF((Y+WW-B
     1)/SY)
      A=((DW-Z)/SZ)**2
      AA=((Z+DW)/SZ)**2
      C1=CMAX*(EXP(-A)+EXP(-AA))
      C2=ERF((Y+B)/SY)-ERF((Y-B)/SY)+ESP
      CONC=C1*C2
      GO TO 30
C
C     CALCULATE WATER CONCENTRATION USING FAR-STREAM MODEL
C
   25 DOTM=DISRT/W
      CONC=DISRT/(WW*DW*US)
C
C     CALCULATE TIME AT WHICH ALL CHEMICAL GOES BY SPECIFIED POINT XYZ
C
   30 CLRTM=TIME+DISTM+(XD/US)
      RETURN
      END
 -END OF FILE-
```

6. CYBERNET USE

Given the HACS/UIM source program file, and the external data files used by HACS, the execution of HACS is obtained by issuing the appropriate commands after logging onto the Cybernet system. Authorization and access procedures for use are provided by the National Response Center.

Execution of HACS requires the process of compiling the source program file(s), loading these programs together with system utilities and library routines, then executing the resulting overlay load module file. On Cybernet, these procedures are carried out as separate steps (during development) to prepare the load module file, and the instructions to access this file are stored in a separate file (procedure). These instructions are:

```
ATTACH,UIMABS.
ATTACH,TAPE9=PCKPRP.
GET,TAPE10=HACST10.
ATTACH,TAPE11=FLDTXT.
ATTACH,TAPE12=SCNTXT.
GET,TAPE13=MODDIR.
UIMABS.
```

These instructions are stored in a procedure file named UIMRUN, and the only user entry required (after log-on) is to type -UIMRUN.

The procedure establishes the required linkages between the internal HACS file references and the external files cataloged on Cybernet. The current external files accessed on Cybernet are:

PCKPRP = chemical properties file
HACST10 = default file
FLDTXT = data item explanatory messages
SCNTXT = scenario descriptions
MODDIR = model descriptions

The file UIMABS contains the HACS/UIM program code load modules in overlay form. Files UIMABS, PCKPRP, FLDTXT, and SCNTXT are direct access files; HACST10 and MODDIR are indirect access files.

The statements ATTACH and GET also establish correspondence (e.g., via TAPE9=PCKPRP) from the internal HACS/UIM file reference numbers 9, 10, 11, 12 and 13 to the appropriate external files.

7. ASSOCIATED PROGRAMS

During the development of the HACS/UIM, a number of associated programs were developed and are briefly described in this section together with their listings. These programs are grouped into four classifications:

7.1 Chemical Property File Manipulation,

7.2 Message File Creation,

7.3 Message File Display, and

7.4 Utilities.

The property file manipulation programs include the conversion from the prior fixed length format used on both Cybernet and the CDC 3300 to the variable length format containing both model and scenario codes used on Cybernet with the UIM. Additional programs relating directly to UIM use in this section include property file data editing and conversions between variable length format and a variable logical record length format packed into a fixed physical record length format. Finally, this section includes three additional programs used to obtain analyses of property file content: an index of chemical recognition codes by hazard assessment model; an index of chemical recognition codes by hazard assessment path codes; and, data gap identification.

Sections 7.2 and 7.3 contain the programs used to build, then display, respectively, the message text files for data fields, scenarios and assessment models. The master programs for file building and display functions were first created for the field text file, then modified as necessary for the scenario and model messages. It was considered likely that over time changes or refinements in explanations for the data fields would be desired, and these programs include capabilities for file maintenance. The creation of the scenario and model descriptions was considered less susceptible to change (and they are also smaller), so file maintenance capabilities were not included.

Two additional programs are included in Section 7.4 as utilities. The first is a very generalized set of individual, and related, data coding and uncoding utility routines which were developed for use in compacting file structures such as the HACS physical property file. These routines are very generalized, and only a sub-set is used within HACS and related property file programs. The second program in Section 7.4 is a straightforward utility used during terminal entry of program code and message text to provide a translation of tab key entries.

7.1 Chemical Property File Manipulation

7.1.1 Model and Scenario Coding

Program CMPRS, listed on the following pages, is used to create a modified version of the property file in which model and scenario codes are appended to each chemical data record, provision for missing chemical data items in the record is deleted, and a file of variable length records is created.

The program requires the use of the data compression utility routines given in Section 7.4.1.

A fixed record length version of the property file is read on input, and the file header (elements unchanged) is copied to output. Next a loop is entered to read each individual chemical data record. The original model codes in the hazard assessment path code from the file are compared to a list of code letters in the program, and a code is set for each model in the sequence determined by the internal list. The resulting codes are then packed for output into a single word. Note that this translation produces a completely uniform specification of hazard assessment model codes for all 900 chemicals.

After a verification of the model letter coding, the model letter codes established from the input file are then used with specific logic in the program to define all hazard assessment scenario codes applicable for the particular chemical. These codes are created and then packed into a single code word for output with the chemical record. A verification step (uncoding and compare) is also included to test the validity of the coded output.

Finally a third coding procedure is performed to omit all chemical data items which are missing (formerly stored as a value of 0.0). The chemical data item status codes (0 = missing, 2 = estimate, 3 = exact) are packed into a five word array for output, and the spaces formerly allocated for missing items are then deleted. The final coded variable length chemical data record is then written to the output file using the statement BUFFER OUT (to obtain the desired variable length characteristic on Cybernet).

The program produces a printed audit of the conversion/compaction process at the user terminal.

81/09/18. 09.31.28.
PROGRAM SAVPCK

```
      PROGRAM CMPRS(OUTPUT,TAPE6=OUTPUT,TAPE9,TAPE10)
      DIMENSION FREF(84),IPTH(16),MFLG(29),YNAM(5),YPTH(8),YVAL(74)
     0INTEGER   BUFF(17),FCM,FLN,FND,FNE,FNM,FNX,FSN,HDR(6),OREC(84),
     1          OTP,PTLST(30),SCLST(28),SCOD,SF01,SF02,SF03,SF04,SF05,
     2          SF06,SF07,SF08,SF09,SF10,SF11,SF12,SF13,SF14,SF15,SF16,
     3          SF17,SF18,SF19,SF20,SF21,SF22,SF23,SF24,SF25,SF26,SF27,
     4          SF28,SFLG(28),TCOD(5),YCOD,YTYP(74)
     0EQUIVALENCE (FREF(1),OREC(1)),(HDR(1),OREC(1)),(IBLNK,PTLST(30)),
     1           (MCOD,OREC(7)),(SCOD,OREC(8)),(TCOD(1),OREC(9)),
     2           (YCOD,YVAL(1)),(YNAM(1),OREC(2))
     0EQUIVALENCE (MSWB,MFLG(2)),(MSWC,MFLG(3)),(MSWD,MFLG(4)),
     1           (MSWE,MFLG(5)),(MSWF,MFLG(6)),(MSWH,MFLG(8)),
     2           (MSWI,MFLG(9)),(MSWK,MFLG(11)),(MSWL,MFLG(12)),
     3           (MSWM,MFLG(13)),(MSWO,MFLG(15)),(MSWP,MFLG(16)),
     4           (MSWQ,MFLG(17)),(MSWR,MFLG(18)),(MSWT,MFLG(20)),
     5           (MSWU,MFLG(21)),(MSWV,MFLG(22)),(MSWX,MFLG(24)),
     6           (MSWY,MFLG(25)),(MSWZ,MFLG(26)),(MSWII,MFLG(27)),
     7           (MSWRR,MFLG(28)),(MSWSS,MFLG(29))
     0EQUIVALENCE (SF01,SFLG( 1)),(SF02,SFLG( 2)),(SF03,SFLG( 3)),
     1           (SF04,SFLG( 4)),(SF05,SFLG( 5)),(SF06,SFLG( 6)),
     2           (SF07,SFLG( 7)),(SF08,SFLG( 8)),(SF09,SFLG( 9)),
     3           (SF10,SFLG(10)),(SF11,SFLG(11)),(SF12,SFLG(12)),
     4           (SF13,SFLG(13)),(SF14,SFLG(14)),(SF15,SFLG(15)),
     5           (SF16,SFLG(16)),(SF17,SFLG(17)),(SF18,SFLG(18)),
     6           (SF19,SFLG(19)),(SF20,SFLG(20)),(SF21,SFLG(21)),
     7           (SF22,SFLG(22)),(SF23,SFLG(23)),(SF24,SFLG(24)),
     8           (SF25,SFLG(25)),(SF26,SFLG(26)),(SF27,SFLG(27)),
     9           (SF28,SFLG(28))
C
      DATA ITP/9/,LP/6/,OTP/10/
     0DATA (PTLST(I),I=1,30)/1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,
     1     1HK,1HL,1HM,1HN,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,
     2     1HZ,2HII,2HRR,2HSS,1H /
     0DATA (SCLST(I),I=1,28)/3HA B,3HA C,5HA B C,5HA D E,7HA D F G,
     1     9HA D E F G,3HA H,5HA I J,7HA H I J,5HA K L,7HA K M N,
     2     9HA K L M N,3HA O,3HA P,5HA P Q,7HA P R S,9HA P Q R S,
     3     3HA T,5HA T U,5HA V W,9HA T U V W,3HA X,5HA X Y,1HZ,2HII,
     4     2HRR,4HRR C,2HSS/
C
C
C--------REWIND INPUT PROPERTY FILE AND READ HEADER RECORD.  TERMINATE
C         IF GET END OF FILE.
      REWIND ITP
      READ(ITP) HDR
      IF(EOF(ITP)) 220,10
C
C--------REWIND OUTPUT FILE AND WRITE VARIABLE LENGTH HEADER RECORD.
C         NOTE THAT RECORD IS WRITTEN IN ODD PARITY AND STATUS TEST IS
C         REQUIRED BEFORE FURTHER EXECUTION.
   10 REWIND OTP
      BUFFER OUT(OTP,1) (HDR(1),HDR(6))
      IF(UNIT(OTP)) 20,230,240
C
C--------INITIALIZE SUMMARY TOTALS FOR FILE PROCESSING COUNTS OF
C         CONVERTED ITEMS AND WRITE OUTPUT HEADER
   20 FCM=0
      FLN=0
      FNX=0
      FNE=0
      FND=0
      FNM=0
      FSN=0
      WRITE(LP,990)
C
C--------RETURN HERE TO READ NEXT PHYSICAL PROPERTY RECORD
   30 READ(ITP) YTYP,YVAL(1),YNAM,YPTH,(YVAL(I),I=4,74)
C
```

```
C--------TEST FOR END OF FILE ON INPUT.  WRITE EOF TO OUTPUT, REWIND
C        BOTH TAPES, WRITE FILE CONVERSION SUMMARY TOTALS AND STOP.
      IF(EOF(ITP)) 40,50
   40 ENDFILE OTP
      REWIND OTP
      REWIND ITP
      WRITE(LP,1000) FCM,FLN,FNX,FNE,FND,FNM,FSN
      STOP
C
C--------CHEMICAL NAME READ ON INPUT IS EQUIVALENCED TO DESIRED
C        LOCATION IN OUTPUT BUFFER.  PREPARE TO CODE MODEL LETTERS
C        BY FIRST UNPACKING PATH CODES IN A8 FORMAT TO A4 FORMAT.
C        INCREMENT COUNT OF CHEMICAL RECORDS AND MOVE CHEMICAL
C        RECOGNITION CODE TO OUTPUT BUFFER.
   50 FCM=FCM+1
      OREC(1)=YCOD
      DECODE(80,1010,YPTH) IPTH
C
C--------LOOP ON ALL NON-BLANK MODEL CODES IN ARRAY IPTH, LOOK EACH UP
C        IN MASTER LIST PTLST.  IF MATCH TO ELEMENT PTLST(I), SET
C        INDICATOR MFLG(I) TO 1, OTHERWISE LEAVE INITIAL VALUE MFLG(I)
C        OF ZERO UNCHANGED.  WRITE ERROR MESSAGE IF ANY NON-BLANK
C        UNRECOGNIZABLE MODEL CODES ARE FOUND ON INPUT.
      DO 60 I=1,29
   60 MFLG(I)=0
      DO 80 I=1,16
      ITMP=IPTH(I)
      IF(ITMP.EQ.IBLNK) GO TO 80
      DO 70 J=1,29
      IF(ITMP.NE.PTLST(J)) GO TO 70
      MFLG(J)=1
      GO TO 80
   70 CONTINUE
      WRITE(LP,1030) ITMP
      STOP
   80 CONTINUE
C
C--------SETTINGS OF ARRAY ELEMENT MFLG(I) ARE NOW 0 IF MODEL I NOT
C        PRESENT, 1 IF PRESENT.  PACK INTO SINGLE CODE WORD MCOD FOR
C        OUTPUT.
      CALL INIT(MCOD,29,1,1)
      CALL PACK(MFLG,MCOD)
C
C--------READ EACH SETTING OF PACKED CODE WORD MCOD, COMPARE TO
C        MFLG FOR VERIFICATION AND MOVE UP TO 10 PATH CODE LETTERS
C        INTO PRINT BUFFER FOR DISPLAY.
      K=0
      DO 90 I=1,29
      ITMP=ITST(MCOD,I)
      IF(ITMP.EQ.MFLG(I)) GO TO 85
      WRITE(LP,1050) I
      STOP
   85 IF(ITMP.EQ.0) GO TO 90
      IF(K.GE.10) GO TO 90
      K=K+1
      BUFF(K)=PTLST(I)
   90 CONTINUE
   92 IF(K.GE.10) GO TO 94
      K=K+1
      BUFF(K)=IBLNK
      GO TO 92
C
C--------USE SETTINGS IN ARRAY MFLG TO IDENTIFY SCENARIOS.  SET VALUES
C        IN ARRAY SFLG TO 1 IF SCENARIO I IS PRESENT, 0 OTHERWISE.
C        START WITH MODELS RR AND C FOR SCENARIOS RR, RR-C.
   94 DO 100 I=1,28
  100 SFLG(I)=0
      IF(MSWRR.EQ.0) GO TO 120
      IF(MSWC.EQ.0) GO TO 110
      SF27=1
      GO TO 170
  110 SF26=1
```

```
C
C--------SCENARIOS FOR MODELS O, Z, II, SS
  120 SF13=MSWO
      SF24=MSWZ
      SF25=MSWII
      SF28=MSWSS
C
C--------SCENARIOS A-B, A-C AND A-B-C
      SF01=MSWB
      SF02=MSWC
      SF03=(MSWB+MSWC)/2
C
C--------SCENARIOS A-D-E, A-D-F-G AND A-D-E-F-G
      SF04=MSWE
      SF05=MSWF
      SF06=(MSWE+MSWF)/2
C
C--------SCENARIOS A-H, A-I-J AND A-H-I-J
      SF07=MSWH
      SF08=MSWI
      SF09=(MSWH+MSWI)/2
C
C--------SCENARIOS A-K-L, A-K-M-N AND A-K-L-M-N
      SF10=MSWL
      SF11=MSWM
      SF12=(MSWL+MSWM)/2
C
C--------SCENARIOS A-P, A-P-Q, A-P-R-S AND A-P-Q-R-S
      IF(MSWP.EQ.0) GO TO 130
      SF15=MSWQ
      SF16=MSWR
      ITMP=MSWQ+MSWR
      SF17=ITMP/2
      IF(ITMP.EQ.0) SF14=1
C
C--------SCENARIOS A-T, A-T-U, A-V-W AND A-T-U-V-W.  IF MODELS U AND V
C          ARE GIVEN WITHOUT T, ONLY SCENARIO A-V-W IS OBTAINED.  IF T
C          AND V ARE GIVEN WITHOUT U, ONLY A-T IS OBTAINED SINCE A-T-V-W
C          IS INVALID AS A COMPLETE SCENARIO.
  130 IF(MSWT.EQ.0) GO TO 150
      IF(MSWU.EQ.1) GO TO 140
      SF18=1
      GO TO 160
  140 SF19=1
      SF21=MSWV
  150 SF20=MSWV
C
C--------SCENARIOS A-X AND A-X-Y
  160 IF(MSWX.EQ.0) GO TO 170
      SF23=MSWY
      IF(MSWY.EQ.0) SF22=1
C
C--------SETTINGS OF ARRAY ELEMENT SFLG(I) NOW DEFINE PRESENCE (1) OR
C          ABSENCE (0) OF SCENARIO I.  PACK INTO SINGLE CODE WORD SCOD
C          FOR OUTPUT.
  170 CALL INIT(SCOD,28,1,1)
      CALL PACK(SFLG,SCOD)
C
C--------READ EACH SETTING OF PACKED CODE WORD SCOD AND COMPARE TO
C          SFLG FOR VERIFICATION.  MOVE SCENARIO CODE LETTERS INTO PRINT
C          BUFFER FOR DISPLAY.  NOTE THAT A LIMIT OF 7 SCENARIOS CAN BE
C          DISPLAYED.
      DO 180 I=1,28
      ITMP=ITST(SCOD,I)
      IF(ITMP.EQ.SFLG(I)) GO TO 175
      WRITE(LP,1070) I
      STOP
  175 IF(ITMP.EQ.0) GO TO 180
      FSN=FSN+1
      IF(K.GE.17) GO TO 180
      K=K+1
      BUFF(K)=SCLST(I)
```

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END

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2 82

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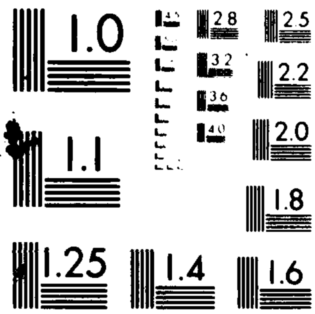

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
  180 CONTINUE
C
C--------CONVERT CHEMICAL DATA ITEM STATUS CODES READ ON INPUT AS ONE
C        CODE PER ELEMENT OF ARRAY YTYP TO PACKED FORMAT IN CODE WORD
C        ARRAY TCOD.  NOTE THAT CODE VALUES ALLOWED ARE 0,1,2,3 WHICH
C        PROVIDES FOR ADDITION OF CHEMICAL SPECIFIC DEFAULT ITEMS AS
C        CODE 1.  THE CODE ARRAY TCOD CONTAINS 5 WORDS OF WHICH 30 BITS
C        EACH ARE USED.  THE PACKED CODES ARE EACH 2 BITS IN LENGTH SO
C        A TOTAL OF 75 CODES CAN BE STORED.  SINCE ONLY 74 CODES ARE
C        REQUIRED, PACKING IS DONE BY SUBROUTINE SET (SUBROUTINE PACK
C        WOULD REQUIRE ALL 75 CODES TO BE STORED).
      CALL INIT(TCOD,30,5,2)
      DO 190 I=1,74
  190 CALL SET(TCOD,I,YTYP(I))
C
C--------READ EACH SETTING OF PACKED DATA ITEM STATUS CODES AND
C        COMPARE TO ORIGINAL VALUE IN YTYP ARRAY FOR VERIFICATION.
C        USE PACKED CODES TO COUNT DATA ITEM TYPES.
      NX=0
      NE=0
      ND=0
      NM=0
      DO 200 I=1,74
      ITMP=ITST(TCOD,I)
      IF(ITMP.EQ.YTYP(I)) GO TO 195
      WRITE(LP,1080) I
      STOP
  195 IF(ITMP.EQ.0) NM=NM+1
      IF(ITMP.EQ.1) ND=ND+1
      IF(ITMP.EQ.2) NE=NE+1
      IF(ITMP.EQ.3) NX=NX+1
  200 CONTINUE
      FNM=FNM+NM
      FND=FND+ND
      FNE=FNE+NE
      FNX=FNX+NX
C
C--------MOVE ALL NON-MISSING DATA ITEM VALUES IN ARRAY YVAL TO ARRAY
C        FREF FOR OUTPUT.  CODING ASSUMES ONE-WORD FORMAT FOR BOTH
C        INTEGERS AND REAL VALUES, SO THAT FIRST DATA VALUE IS MOVED
C        INTO POSITION 14 OF OUTPUT RECORD.
      LN=13
      DO 210 I=4,74
      IF(YTYP(I).EQ.0) GO TO 210
      LN=LN+1
      FREF(LN)=YVAL(I)
  210 CONTINUE
      FLN=FLN+LN
C
C--------DISPLAY SUMMARY OUTPUT FOR COMPACTED RECORD
      WRITE(LP,1090) YCOD,LN,NX,NE,ND,NM,(BUFF(I),I=1,K)
C
C--------WRITE COMPRESSED DATA RECORD TO OUTPUT FILE, THEN RETURN
C        FOR NEXT CHEMICAL AFTER ERROR FREE OUTPUT.
      BUFFER OUT(OTP,1) (OREC(1),OREC(LN))
      IF(UNIT(OTP)) 30,230,240
C
C--------NON-RECOVERABLE ERROR CONDITIONS
  220 WRITE(LP,1100)
      STOP
  230 WRITE(LP,1110)
      STOP
  240 WRITE(LP,1120)
      STOP
C
 9900FORMAT (//75H SUMMARY REPORT ON SCENARIO CODING AND COMPACTION OF
     1CHEMICAL PROPERTY FILE//44H COD LN NX NE ND NM HAZARD ASSESSMENT M
     2ODELS,7X,76HSCENARIO 1 SCENARIO 2 SCENARIO 3 SCENARIO 4 SCENARIO 5
     3 SCENARIO 6 SCENARIO 7/20H --- -- -- -- -- -- ,30(1H-),7(1X,10(1H-
     4)))
10000FORMAT (//5X,22HCONVERTED FILE TOTALS://5X,I5,33H VARIABLE LENGTH
     1CHEMICAL RECORDS/5X,I5,33H WORDS FOR COMPACTED FILE STORAGE/5X,I5,
```

```
     225H EXACT DATA VALUES STORED/5X,I5,29H ESTIMATED DATA VALUES STORE
     3D/5X,I5,27H DEFAULT DATA VALUES STORED/5X,I5,28H MISSING DATA VALU
     4ES SKIPPED/5X,I5,22H SCENARIO CODES STORED///)
 1010 FORMAT (8(2A4,2X))
 1030 FORMAT (5X,26H*****UNKNOWN MODEL CODE = ,A10)
 1050 FORMAT (5X,25H*****ERROR ON MODEL CODE ,I2,13H VERIFICATION)
 1070 FORMAT (5X,28H*****ERROR ON SCENARIO CODE ,I2,13H VERIFICATION)
 1080 FORMAT (5X,26H*****ERROR ON STATUS CODE ,I2,13H VERIFICATION)
 1090 FORMAT (1X,A3,5(1X,I2),1X,10A3,7(1X,A10))
 1100 FORMAT (5X,44H*****ERROR - HEADER ON INPUT PRECEDED BY EOF)
 1110 FORMAT (5X,21H*****EOF ERROR ON OTP)
 1120 FORMAT (5X,24H*****PARITY ERROR ON OTP)
      END
READY.
```

7.1.2 Variable to Fixed Length Conversion

On Cybernet, it was found that variable length records were written in either a variable length or fixed length format depending on the program statements used, and the operating procedures used (e.g., PACK). The BUFFER OUT/BUFFER IN statements currently used in HACS/UIM provide, without packing the chemical data file, the desired variable length structure.

A brief review of the standard Fortran features available on both DEC and PRIME computers indicated that some difficulty in building similar variable length file structures might be encountered in conversion, and two additional programs were created.

The first, PROGRAM CONV, is listed in the following section, and provides for the conversion of a variable record length file created by PROGRAM CMPRS (refer to Section 7.1.1) to a file in which the variable length records are packed into fixed length physical records. Output is performed by unformatted WRITE statements instead of BUFFER OUT.

Subroutine MVLRC (refer to Section 7.1.3) provides for input conversion of the file created by this program. Neither CONV nor MVLRC are used by the current version of HACS/UIM on Cybernet; these are provided for future use on DEC or PRIME installations as may be desired.

```
 81/09/18. 09.33.47.
PROGRAM   RGPBTB

      PROGRAM CONV(OUTPUT,TAPE6=OUTPUT,TAPE9,TAPE10)
C
C         PROGRAM CONV (FOR CONVERT) READS AN INPUT CHEMICAL PROPERTY
C         FILE CONTAINING VARIABLE LENGTH RECORDS CREATED BY USING THE
C         BUFFER OUT STATEMENT, AND A RECORD LENGTH IS APPENDED TO THE
C         BEGINNING OF EACH RECORD.  UNFORMATTED, FIXED LENGTH BINARY
C         RECORDS ARE WRITTEN TO THE OUTPUT FILE.  THE LAST OUTPUT FIXED
C         LENGTH RECORD IS FILLED WITH ZEROES IF NECESSARY.  FOR SUB-
C         SEQUENT SEQUENTIAL INPUT FROM THE FIXED LENGTH RECORD FILE, THE
C         LOGICAL RECORD LENGTH IN THE RECORD IS REQUIRED TO CONTROL
C         INPUT OF FIXED LENGTH RECORDS TO RECONSTRUCT THE DESIRED
C         VARIABLE LENGTH LOGICAL RECORD.
C
C
C         BLEN    = FIXED LENGTH OF OUTPUT RECORD BUFFER, SET HERE TO 63
C                     FOR CORRESPONDENCE WITH MINIMUM CDC MASS STORAGE
C                     DISK ALLOCATION
C         I       = INDEX TO ELEMENTS OF VARIABLE LENGTH INPUT RECORD
C         IREC    = BUFFER FOR STORAGE OF INPUT VARIABLE LENGTH RECORD.
C                     MAXIMUM RECORD LENGTH (ON INPUT) IS 84 WORDS TO
C                     TO BE STORED IN POSITIONS 2 TO 85 OF IREC.
C         ITP     = I/O UNIT NUMBER FOR INPUT FILE
C         J       = INDEX TO ELEMENTS IN FIXED LENGTH OUTPUT BUFFER,
C                     CYCLES BETWEEN 1 AND BLEN BY 1.
C         LEN     = ADJUSTED LENGTH OF VARIABLE LENGTH INPUT RECORD (ONE
C                     IS ADDED TO ADJUST FOR STORAGE OF LENGTH COUNT)
C         LP      = I/O UNIT NUMBER FOR PARITY ERROR MESSAGE
C         OREC    = OUTPUT BUFFER, FIXED LENGTH = BLEN
C         OTP     = I/O UNIT NUMBER FOR OUTPUT FILE
C
C         COMMON VARIABLES USED - NONE
C
C         SUBROUTINES REQUIRED  - LENGTH,UNIT
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                              35/318A ACORN PARK,
C                              CAMBRIDGE, MASS., 02140
C                              TEL. 617-864-5770  EXT. 2813
C
C
C         DATE    - 16 JANUARY 1981
C
C
      INTEGER      BLEN,OREC,OTP
      DIMENSION    IREC(85),OREC(63)
      EQUIVALENCE (LEN,IREC(1))
      DATA         BLEN/63/,ITP/9/,LP/6/,OTP/10/
C
C
C--------INITIALIZE, REWIND BOTH FILES AND SET OUTPUT BUFFER POINTER
C         TO EMPTY VALUE.
      REWIND ITP
      REWIND OTP
      J=0
C
C--------RETURN HERE TO READ EACH NEW INPUT RECORD UNTIL EOF OR PARITY
C         ERROR IS ENCOUNTERED.  INPUT RECORD IS READ INTO ARRAY IREC
C         FROM POSITION 2 ON.  TEST FOR EOF OR PARITY ERROR AND BRANCH
C         TO PROCESS.  OTHERWISE OBTAIN LENGTH OF INPUT RECORD, AND
C         STORE LENGTH OF OUTPUT RECORD (=INPUT LENGTH + 1) IN POSITION
C         1 OF IREC.
   10 BUFFER IN(ITP,1) (IREC(2),IREC(85))
      IF(UNIT(ITP)) 20,40,60
   20 LEN=LENGTH(ITP)+1
C
C--------MOVE WORDS 1 TO LEN FROM INPUT ARRAY IREC TO POSITION IN OUTPUT
C         ARRAY OREC.  EACH TIME OREC IS FILLED TO CAPACITY (BLEN), WRITE
C         OUTPUT RECORD AND RE-INITIALIZE TO STORE NEXT WORD FROM IREC
```

```
C         IN FIRST POSITION OF OREC.
      DO 30 I=1,LEN
      J=J+1
      IF(J.LE.BLEN) GO TO 30
      WRITE(OTP) OREC
      J=1
   30 OREC(J)=IREC(I)
C
C---------AFTER ALL ELEMENTS OF IREC HAVE BEEN MOVED TO OUTPUT, RETURN
C         TO CONTINUE CYCLE FOR NEXT INPUT RECORD UNTIL EOF ON INPUT IS
C         REACHED.
      GO TO 10
C
C---------EOF ON INPUT UNIT HAS BEEN REACHED.  FILL LAST OUTPUT BUFFER
C         WITH ZEROES, THEN WRITE OREC AND TERMINATE RUN.
   40 J=J+1
      IF(J.GT.BLEN) GO TO 50
      OREC(J)=0
      GO TO 40
   50 WRITE(OTP) OREC
      ENDFILE OTP
      GO TO 70
C
C---------PARITY ERROR CONDITION.  WRITE ERROR MESSAGE AND TERMINATE RUN.
   60 WRITE(LP,1000)
   70 REWIND OTP
      REWIND ITP
      STOP
 1000 FORMAT (47H *****PARITY ERROR ON INPUT TAPE.  JOB ABORTED.//)
      END
READY.
```

7.1.3 Fixed to Variable Length Conversion

Referring to Section 7.1.2 for additional information, Subroutine MVLRC listed on the following pages can be used to read a blocked fixed length file of chemical property data and extract the desired variable length chemical data record. Program TEST which precedes MVLRC in the listing is a short test program used to read the data file, and print selected information. This program illustrates the method used to read the data file, and can be used as a model for HACS/UIM revision if the file structure is changed during conversion. Subroutine MVLRC does not currently appear in the Cybernet operating version of HACS/UIM. Note that subroutine MVLRC processes the input file using only unformatted READ statements.

```
 81/09/18. 09.36.15.
PROGRAM   RGPMLR

      PROGRAM TEST(OUTPUT,TAPE6=OUTPUT,TAPE9)
      COMMON/SAVE/IERR,IREC(85),J
      INTEGER      YCOD
      EQUIVALENCE (LEN,IREC(1)),(YCOD,IREC(2))
      K=0
   10 CALL MVLRC(K)
      WRITE(6,1000) K,IERR,J,LEN,YCOD
      IF(IERR.EQ.0) GO TO 10
      STOP
 1000 FORMAT (3X,I3,3X,I1,3X,I2,3X,I2,3X,A3)
      END
      SUBROUTINE MVLRC(K)
C
C         SUBROUTINE MVLRC (FOR MOVE LOGICAL RECORD) READS A VARIABLE
C         LENGTH LOGICAL RECORD FROM AN EXTERNAL FILE OF UNFORMATTED
C         (BINARY) FIXED LENGTH RECORDS CONTAINING RECORD LENGTH
C         POINTERS.  THIS ROUTINE IS INTENDED TO BE USED TO MOVE THE
C         LOGICAL RECORDS SEQUENTIALLY FROM THE BEGINNING OF THE FILE
C         TO THE END OF THE FILE.  EACH CALL RETURNS THE NEXT LOGICAL
C         RECORD, STORED IN THE COMMON BLOCK SAVE.  PRIOR TO THE FIRST
C         USE, THE CALLING PROGRAM SHOULD SET THE ARGUMENT K TO ZERO.
C
C
C         BLEN    = FIXED LENGTH OF EXTERNAL FILE RECORDS, SET TO 63
C                       FOR CORRESPONDENCE WITH PROGRAM USED TO CREATE
C                       THE FILE.
C         I       = INDEX TO ELEMENTS IN VARIABLE LENGTH RECORD TO BE
C                       RETURNED TO CALLING PROGRAM
C         IERR    = END OF FILE STATUS INDICATOR RETURNED TO CALLING
C                       PROGRAM.  0 IS NORMAL RETURN, 1 INDICATES END OF
C                       FILE.  ON RETURN WITH IERR=1, THE CONTENTS OF IREC
C                       ARE NOT CHANGED.  K HOWEVER IS UPDATED.
C         IREC    = AREA FOR STORAGE OF VARIABLE LENGTH DATA RECORD, UP TO
C                       A MAXIMUM OF 85 WORDS IN LENGTH.  LENGTH, LEN, IS
C                       STORED IN POSITION 1 ON RETURN IF IERR=0.
C         J       = INDEX TO ELEMENTS IN FIXED LENGTH BUFFER, CYCLES
C                       BETWEEN 1 AND BLEN BY 1.  NOTE THAT J IS SAVED IN
C                       COMMON AND INITIALIZATION IS FORCED BY INITIAL
C                       CALL WITH K=0.
C         K       = NUMERICAL INDEX TO VARIABLE LENGTH RECORDS.  ON INPUT,
C                       VALUE GIVES SEQUENTIAL NUMBER OF RECORD RETURNED BY
C                       LAST CALL.  ON OUTPUT, K GIVES NUMBER OF RECORD
C                       RETURNED BY CURRENT CALL.
C         LEN     = TOTAL LENGTH OF VARIABLE LENGTH RECORD, STORED ON
C                       RETURN IN FIRST LOCATION OF IREC.  MAY BE ZERO ON
C                       RETURN FOR END OF FILE.
C         OREC    = FIXED LENGTH RECORD BUFFER, LENGTH = BLEN
C         OTP     = I/O UNIT NUMBER FOR FIXED LENGTH RECORD FILE
C
C         COMMON VARIABLES USED - IERR,IREC,J,LEN
C
C         SUBROUTINES REQUIRED  - EOF
C
C         AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                              35/318A ACORN PARK,
C                              CAMBRIDGE, MASS., 02140
C                              TEL. 617-864-5770  EXT. 2813
C
C         DATE   - 16 JANUARY 1981
C
C
      COMMON/SAVE/IERR,IREC(85),J
      EQUIVALENCE (LEN,IREC(1))
C
      INTEGER      BLEN,OREC(63),OTP
      DATA         BLEN/63/,OTP/9/
C
```

```
C
C--------FOR INITIAL CALL WITH K=0, REWIND FIXED LENGTH RECORD FILE AND
C        SET BUFFER POINTER TO FORCE FIRST READ.
      IF(K.NE.0) GO TO 10
      REWIND OTP
      J=BLEN
C
C--------INITIALIZE FOR EACH NEW RECORD TO BE RETURNED.  SET ERROR FLAG
C        IERR TO NO ERROR VALUE, AND MOVE K TO NUMBER OF RECORD TO BE
C        RETURNED.  INDEX J IS INCREMENTED TO FIRST POSITION OF NEXT
C        LOGICAL RECORD WHICH CONTAINS THE LENGTH OF THAT RECORD.
   10 IERR=0
      K=K+1
      J=J+1
C
C--------IF POINTER J EXCEEDS LENGTH OF FIXED LENGTH BUFFER, READ NEXT
C        BUFFER AND RESET POINTER TO FIRST POSITION.  JUMP TO EOF RETURN
C        IF END OF FILE IS FOUND, OTHERWISE SAVE LENGTH OF NEXT LOGICAL
C        RECORD.  NOTE THAT ZERO FILL IN LAST FIXED LENGTH BUFFER ALSO
C        INDICATES END OF FILE CONDITION.
      IF(J.LE.BLEN) GO TO 30
      READ(OTP) OREC
      IF(EOF(OTP)) 60,20
   20 J=1
   30 LEN=OREC(J)
      IF(LEN.EQ.0) GO TO 60
C
C--------MOVE ELEMENTS 2 TO LEN INTO VARIABLE LENGTH RECORD FIELDS.
C        READ NEW BUFFER EACH TIME POINTER J MOVES OUT OF RANGE OF
C        FIXED LENGTH BUFFER.  NOTE EOF TEST IS USED FOR EACH READ, AND
C        THAT THIS CODE ASSUMES LEN .GE. 2.  RETURN WHEN DONE.
      DO 50 I=2,LEN
      J=J+1
      IF(J.LE.BLEN) GO TO 50
      READ(OTP) OREC
      IF(EOF(OTP)) 60,40
   40 J=1
   50 IREC(I)=OREC(J)
      RETURN
C
C--------END OF FILE RETURN.  SET IERR AND RETURN.
   60 IERR=1
      RETURN
      END
READY.
```

7.1.4 CDC 3300 Conversion

Program CONV which is listed on the following pages has evolved as the primary means of transferring the chemical property data from the CDC 3300 to other computers. On the CDC 3300 the selective retrieval and display program is run with options selected to output all non-missing data items for all chemicals to an output tape. The tape contains one data item per output record, in the format required for property file updates. (Refer to documentation on the separate retrieval and update programs for additional detailed information.)

Program CONV reads the tape file written on the CDC 3300, and produces as output on the host computer a file written in binary format for use with HACS. Functions performed by CONV include setting status codes, inserting missing data values (0.0) which are not present in the input file, and collecting all input records for a single chemical into a single output record.

The output file produced is formatted as a series of fixed length binary records (original HACS property file format).

```
 81/09/18. 11.49.46.
PROGRAM   RGPCNV

      PROGRAM CONV(OUTPUT,TAPE6=OUTPUT,TAPE9,TAPE10)
      INTEGER EST,HDR,OTP,XCOD,YTYP
      REAL FBLNK,YNAM,YPTH,YVAL
      INTEGER IBLNK
      INTEGER I,IBUF,ITAG,ITP,NFLD,NWCOD
      DIMENSION HDR(6),IBUF(7),YNAM(5),YPTH(8),YTYP(74),YVAL(74)
      EQUIVALENCE (IBLNK,FBLNK),(NWCOD,YVAL(1))
      DATA EST/1HE/,ITP/9/,OTP/10/,IBLNK/1H /
      DATA HDR(6)/4HX246/,HDR(2)/18/,HDR(1)/91678/
      DATA HDR(5)/4HX149/,HDR(4)/19/,HDR(3)/91678/
C
      REWIND OTP
      WRITE(OTP) HDR
      REWIND ITP
   10 READ(ITP,1000) NWCOD,NFLD
 1000 FORMAT (A3,1X,I2)
      IF(EOF(ITP)) 140,20
   20 IF(NFLD.NE.1) GO TO 120
      YTYP(1)=3
      YTYP(2)=3
      YTYP(3)=3
      DO 30 I=4,74
      YTYP(I)=0
   30 YVAL(I)=0.0
      YVAL(11)=FBLNK
      YVAL(69)=FBLNK
   40 READ(ITP,1010) XCOD,NFLD,ITAG,IBUF
 1010 FORMAT (A3,1X,I2,1X,A1,2X,7A10)
      IF(EOF(ITP)) 130,50
   50 IF(XCOD.NE.NWCOD) GO TO 110
      IF(NFLD.LE.1) GO TO 120
      IF(NFLD.GT.74) GO TO 120
      IF(ITAG.NE.IBLNK) GO TO 60
      YTYP(NFLD)=3
      GO TO 70
   60 IF(ITAG.NE.EST) GO TO 120
      YTYP(NFLD)=2
   70 CONTINUE
      IF(NFLD.EQ.2) GO TO 80
      IF(NFLD.EQ.3) GO TO 90
      IF(NFLD.EQ.11) GO TO 100
      IF(NFLD.EQ.69) GO TO 100
      DECODE(16,1100,IBUF) YVAL(NFLD)
 1100 FORMAT (G16.6)
      GO TO 40
   80 DECODE(40,1200,IBUF) YNAM
 1200 FORMAT (5A8)
      GO TO 40
   90 DECODE(64,1300,IBUF) YPTH
 1300 FORMAT (8A8)
      GO TO 40
  100 DECODE(8,1500,IBUF) YVAL(NFLD)
 1500 FORMAT (A8)
      GO TO 40
  110 BACKSPACE ITP
      WRITE(OTP) YTYP,YVAL(1),YNAM,YPTH,(YVAL(I),I=4,74)
      GO TO 10
  120 WRITE(6,1020)
 1020 FORMAT (28H  CONVERSION ERROR OCCURRED.)
      STOP
  130 WRITE(OTP) YTYP,YVAL(1),YNAM,YPTH,(YVAL(I),I=4,74)
  140 ENDFILE OTP
      REWIND OTP
      REWIND ITP
      WRITE(6,1030)
 1030 FORMAT (24H  SUCCESSFUL CONVERSION.)
      STOP

      END
```

7.1.5 Recognition Code/Model Cross-Reference

Three programs, Sections 7.1.5, 7.1.6 and 7.1.7, are all named program GAP, and contain many similarities; each has been adapted however to perform a different function.

In this section, the version of program GAP is used to read a HACS physical property data file and produce a cross-reference listing of chemical recognition codes which include a particular assessment model letter in the path codes on the file. The purpose of these programs was to obtain the cross-reference lists as quickly as possible. Since they will be run very infrequently, efficiency of internal operations was relatively unimportant, and large internal arrays are used to aggregate the required information.

As each chemical record is read, the hazard assessment model letters contained in the path codes on the file are individually stored in an array. A corresponding entry in a second array is made with the chemical recognition code. This process continues until all chemical data records have been read. The program currently allows a maximum of 3000 model references which is adequate for the 900 chemicals; however, this limit will need to be increased as new chemicals are added to the file.

When the input file has been completely processed, a second step is initiated. A single model letter is picked from the list A - Z, II, RR, SS, and the stored array of codes from the property file is searched for all occurrences of that letter. For each occurrence, the corresponding chemical recognition code is moved to another array for printing. The print array (SVCOD) is currently limited to a maximum of 900 entries, corresponding to the number of chemicals which is the maximum number of possible entries in the print array. This size will also need to be expanded as additional chemicals are added to the file.

After the stored code arrays have been entirely searched, the program prints the selected model letter, the number of references, and the list of chemical recognition codes (from the print array) that reference that model in their path codes. Since the alphabetic sequence of the original input file has been preserved, the chemical recognition codes are printed alphabetically within model letter codes.

The second step process is repeated for each different assessment model letter code until chemical recognition codes for all 29 models have been displayed.

```
 81/09/18. 11.50.35.
PROGRAM   RGPMOD

      PROGRAM GAP(INPUT,OUTPUT,TAPE6=OUTPUT,TAPE9)
C
C        PROGRAM TABULATES CHEMICAL RECOGNITION CODES FOR
C        INDIVIDUAL RATE MODELS.
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.
C                             35/318A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C
C        DATE   - 03 JULY 1980
C
C
      DIMENSION HDR(6),IPTH(16),PTLST(30),YNAM(5),YPTH(8),YTYP(74)
      DIMENSION YVAL(74)
      INTEGER   CLST(3000),MLST(3000),SVCOD(900)
      INTEGER   HDR,PTLST,YCOD,YTYP
      EQUIVALENCE (YCOD,YVAL(1))
C
      DATA IBLNK/4H    /,ITP/9/,LP/6/
C
     0DATA (PTLST(I),I=1,30)/
     1      4HA   ,4HB   ,4HC   ,4HD   ,4HE   ,4HF   ,4HG   ,4HH   ,
     2      4HI   ,4HJ   ,4HK   ,4HL   ,4HM   ,4HN   ,4HO   ,4HP   ,
     3      4HQ   ,4HR   ,4HS   ,4HT   ,4HU   ,4HV   ,4HW   ,4HX   ,
     4      4HY   ,4HZ   ,4HII  ,4HRR  ,4HSS  ,4H    /
C
C
C--------REWIND TAPE AND READ HEADER RECORD.  TERMINATE IF GET END FILE.
      REWIND ITP
      READ(ITP) HDR
      IF (EOF(ITP))5,30
C
C--------INITIAL END OF FILE ERROR CONDITION
    5 WRITE(LP,1010)
      REWIND ITP
      STOP
C--------NORMAL RETURN
   20 CONTINUE
      WRITE(LP,1070) M
      DO 24 I=1,29
      MOD=PTLST(I)
      N=0
      DO 22 J=1,M
      IF(MOD.NE.MLST(J)) GO TO 22
      N=N+1
      IF(N.GT.900) GO TO 70
      SVCOD(N)=CLST(J)
   22 CONTINUE
      WRITE(LP,1080) MOD,N
      WRITE(LP,1090) (SVCOD(K),K=1,N)
   24 CONTINUE
C
      REWIND ITP
      STOP
C
C--------PRINT REPORT TITLE AND DISPLAY FILE HEADER
   30 CONTINUE
      M=0
      WRITE(LP,1050)
      WRITE(LP,1020) HDR(5),HDR(4),HDR(3),HDR(6),HDR(2),HDR(1)
C
C--------RETURN HERE TO READ NEXT PHYSICAL PROPERTY RECORD
   40 READ(ITP) YTYP,YVAL(1),YNAM,YPTH,(YVAL(I),I=4,74)
C
C--------TEST FOR END OF FILE.  STOP ON EOF.
      IF(EOF(ITP)) 20,50
```

```
C
C---------PROCESS CHEMICAL RECORD
   50 CONTINUE
C
C----------UNPACK PATH CODES AND STORE IN ARRAY IPTH
      DECODE(80,1040,YPTH) IPTH
      DO 60 I=1,16
      IF(IPTH(I).EQ.IBLNK) GO TO 60
      M=M+1
      IF(M.GT.3000) GO TO 70
      CLST(M)=YCOD
      MLST(M)=IPTH(I)
   60 CONTINUE
      GO TO 40
   70 WRITE(LP,1060)
      REWIND ITP
      STOP
C
C
 1010 FORMAT (/5X,46H*****ERROR - UNABLE TO READ HACS PROPERTY FILF)
 10200FORMAT (/10X,21HFILE OPENED HAS ID = ,A4,20H,  VERSION NUMBER = ,
     1 I5,10H,  DATE = ,I6/13X,18HBACK-UP FILE ID = ,A4,20H,  VERSION NU
     2MBER = ,I5,10H,  DATE = ,I6)
 1030 FORMAT (2X,A3,3X,5A8,3X,8A8)
 1040 FORMAT (8(2A4,2X))
 1050 FORMAT (/5X,43HLIST OF CHEMICAL RECOGNITION CODES BY MODEL//)
 1060 FORMAT (/5X,28H*****ERROR - BUFFER OVERFLOW)
 1070 FORMAT (/5X,35HTOTAL NUMBER OF MODEL REFERENCES = ,I5)
 10800FORMAT (//5X,6HMODEL ,A2,5H HAS ,I3,26H REFERENCES, BY CHEMICALS:
     1 /)
 1090 FORMAT (/14X,10A6)
      END
READY.
```

7.1.6 Recognition Code/Assessment Path Cross-Reference

The version of program GAP which follows performs an almost identical function to the version of program GAP in Section 7.1.5 except that the hazard assessment path codes contained on the input chemical properties file are evaluated in aggregate, not as single model letters. This identifies each different hazard assessment path code contained on the property file, and lists for each the chemical recognition codes of all chemicals giving the particular path code. Note that the hazard assessment scenarios are sub-sets of these path codes, and the information produced by this program was used to validate the rules of scenario formation developed for HACS/UIM.

The program reads each chemical data record and compares the path codes to a stored table of previously read path codes. If the path codes are found in the table, the chemical recognition code is stored in an array. A corresponding pointer is also set linking the recognition code to the table entry. If the path codes are not found in the table, they are appended to the end of the table as a new entry. The recognition code and linking pointer are stored as before. The program currently limits the size of this table to 100 different hazard assessment path codes; this should allow some expansion beyond the current 900 chemicals before an increase is required. However, the arrays of saved recognition codes and linking pointers are limited to 900 entries and expansion will be required as new chemicals are added to the file.

The second portion of the program simply loops through the stored table of different path codes. The table index is used to link to the stored array of chemical recognition codes to identify each chemical listing the indexed path code, and a printed display is produced.

Since the path code table is generated as the chemicals are processed, alphabetically by chemical recognition code, and since table entries are made using exact character matches, the resulting output report has the following characterisitics:

- The path codes are listed in sequence according to the first appearance on the property file.

- Within each path code, chemicals are listed alphabetically by chemical recognition code.

- Logically equivalent path codes may appear more than once in the display containing the same model letter codes arranged in different sequence.

81/09/18. 11.51.33.
PROGRAM RGPPTH

```
      PROGRAM GAP(INPUT,OUTPUT,TAPE6=OUTPUT,TAPE9)
C
C        PROGRAM TO TABULATE UNIQUE PATH CODES ON FILE.
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.
C                             35/318A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C
C        DATE   - 03 JULY 1980
C
C
     0DIMENSION HDR(6),IPTH(16),IREQ(74),LIST(14,74),LREF(30),PBUF(74),
     1          PTLST(30),YNAM(5),YPTH(8),YTYP(74),YVAL(74)
      DIMENSION NEST(74),NEXT(74),NGAP(74),NTOT(74)
      INTEGER   HDR,PBUF,PTLST,YCOD,YTYP
      INTEGER   SVCOD(900),SVPTH(900),PRCOD(900)
      EQUIVALENCE (YCOD,YVAL(1))
      INTEGER CNT(100),TOT
      DIMENSION TAB(100,8)
C
      DATA IBLNK/4H    /,ITP/9/,LP/6/
C
     0DATA (PTLST(I),I=1,30)/
     1      4HA   ,4HB   ,4HC   ,4HD   ,4HE   ,4HF   ,4HG   ,4HH   ,
     2      4HI   ,4HJ   ,4HK   ,4HL   ,4HM   ,4HN   ,4HO   ,4HP   ,
     3      4HQ   ,4HR   ,4HS   ,4HT   ,4HU   ,4HV   ,4HW   ,4HX   ,
     4      4HY   ,4HZ   ,4HII  ,4HRR  ,4HSS  ,4H    /
C
C
C--------REWIND TAPE AND READ HEADER RECORD.  TERMINATE IF GET END FILE.
      REWIND ITP
      READ(ITP) HDR
      IF (EOF(ITP))5,30
C
C--------INITIAL END OF FILE ERROR CONDITION
    5 WRITE(LP,1010)
      STOP
C--------NORMAL RETURN
   20 CONTINUE
      TOT=0
      WRITE(LP,1090) N
 1090 FORMAT (/5X,14HFILE CONTAINS ,I2,21H DIFFERENT PATH CODES/)
      DO 21 I=1,N
      TOT=TOT+CNT(I)
      WRITE(LP,1070) CNT(I),(TAB(I,J),J=1,8)
 1070 FORMAT (//5X,I3,25H OCCURRENCES OF PATH:     ,8A8/)
      L=0
      DO 22 J=1,900
      IF(SVPTH(J).NE.I) GO TO 22
      L=L+1
      PRCOD(L)=SVCOD(J)
   22 CONTINUE
      WRITE(LP,1100) (PRCOD(K),K=1,L)
 1100 FORMAT (/10X,10A6)
   21 CONTINUE
      WRITE(LP,1080) TOT
 1080 FORMAT (5X,5H-----/5X,I5)
C
      REWIND ITP
      STOP
C
C--------PRINT REPORT TITLE AND DISPLAY FILE HEADER
   30 CONTINUE
      WRITE(LP,1050)
      M=0
      N=0
```

```
      DO 25 I=1,100
   25 CNT(I)=0
      WRITE(LP,1020) HDR(5),HDR(4),HDR(3),HDR(6),HDR(2),HDR(1)
C
C--------RETURN HERE TO READ NEXT PHYSICAL PROPERTY RECORD
   40 READ(ITP) YTYP,YVAL(1),YNAM,YPTH,(YVAL(I),I=4,74)
C
C--------TEST FOR END OF FILE.  STOP ON EOF.
      IF(EOF(ITP)) 20,50
C
C--------PROCESS CHEMICAL RECORD
   50 CONTINUE
C
C--------COUNT IF PATH ALREADY IN TABLE, OTHERWISE ADD TO TABLE.
      IF(N.EQ.0) GO TO 80
      DO 70 I=1,N
      DO 60 J=1,8
      IF(YPTH(J).NE.TAB(I,J)) GO TO 70
   60 CONTINUE
      M=M+1
      SVCOD(M)=YCOD
      SVPTH(M)=I
      CNT(I)=CNT(I)+1
      GO TO 40
   70 CONTINUE
   80 N=N+1
      IF(N.GT.100) GO TO 100
      DO 90 J=1,8
   90 TAB(N,J)=YPTH(J)
      CNT(N)=CNT(N)+1
      M=M+1
      SVCOD(M)=YCOD
      SVPTH(M)=N
      GO TO 40
  100 WRITE(LP,1060)
      STOP
C
 1010 FORMAT (/5X,46H*****ERROR - UNABLE TO READ HACS PROPERTY FILE)
 1020 FORMAT (/10X,21HFILE OPENED HAS ID = ,A4,20H,  VERSION NUMBER = ,
     1 I5,10H,  DATE = ,I6/13X,18HBACK-UP FILE ID = ,A4,20H,  VERSION NU
     2MBER = ,I5,10H,  DATE = ,I6)
 1030 FORMAT (2X,A3,3X,5A8,3X,8A8)
 1040 FORMAT (8(2A4,2X))
 1050 FORMAT (//5X,26HTABLE OF UNIQUE PATH CODES//)
 1060 FORMAT (/5X,14HTABLE OVERFLOW)
      END
READY.
```

7.1.7 Data Gap Identification

The version of program GAP which follows is the master chemical property file data gap identification program which correlates data values missing on the property file with actual HACS model input requirements.

Matrix elements are set in the program to define the correspondence between HACS model inputs and individual property data items. Note that the program cannot distinguish among different conditions which may occur within a rate model, that is, property input required under some conditions but not others.

The following program listing gives detailed documentation. Note that the program can also be modified (refer to comments in the listing) to perform selective screening functions and these steps were used to develop the overall data gap analyses.

81/09/18. 11.52.38.
PROGRAM   RGPGAP

```
      PROGRAM GAP(INPUT,OUTPUT,TAPE6=OUTPUT,TAPE9)
C
C         PROGRAM GAP READS AS INPUT A HACS PHYSICAL PROPERTY DATA
C         FILE (TAPE9) AND PRODUCES AS OUTPUT A PRINTED REPORT
C         IDENTIFYING ALL DATA GAPS BY PROPERTY ITEM FIELD NUMBER.
C         A DATA GAP IS DEFINED AS A PROPERTY ITEM WHICH MAY BE REQUIRED
C         BY AT LEAST ONE OF THE MODELS IN THE PATH CODE ON THE FILE
C         AND WHICH HAS A CURRENT STATUS TAG OF MISSING.  CORRESPONDENCE
C         BETWEEN THE CURRENT HACS MODELS AND PROPERTY DATA ITEMS IS
C         GIVEN BY THE ELEMENTS IN THE DATA ARRAY LIST.  ANY MODEL
C         CHANGES OR REVISIONS RELATED TO THE USE OF PROPERTY DATA MAY
C         ALSO REQUIRE UPDATES TO THIS ARRAY.
C
C         THE ARRAY LREF CONTROLS THE INDEXING FROM AN ALPHABETIC MODEL
C         CODE, OBTAINED FROM THE INPUT PROPERTY FILE IN THE ARRAY IPTH,
C         TO THE APPROPRIATE ENTRY IN THE LIST OF REQUIRED ITEMS, LIST.
C         THE PROGRAM CAN BE ADAPTED FOR SELECTIVE DATA GAP SCREENING
C         BY MODIFYING DATA VALUES IN THE ARRAY LREF.  A VALUE IN LREF
C         OF 0 INDICATES THE CORRESPONDING MODEL EITHER DOES NOT REQUIRE
C         PROPERTY DATA, OR HAS BEEN OMITTED FROM THE SCREEN.
C
C         THE PROGRAM MAY ALSO BE ADAPTED FOR SELECTIVE SCREENING
C         BY SPECIFIC PROPERTY ITEMS BY EITHER MODIFYING THE ELEMENTS
C         OF THE ARRAY LIST WHICH ARE SET TO 1, OR BY ALLOWING ONLY
C         SELECTED VALUES OF IREQ TO BE SET TO 1 IN THE DO LOOP ON J
C         TO STATEMENT 90.  FOR EXAMPLE, THIS COULD BE USED TO ISOLATE
C         ALL ACTUAL DATA GAPS FOR A SINGLE TEMPERATURE FUNCTION.
C
C         AFTER PRINTING IDENTIFICATION OF ALL DATA GAPS FOR EACH
C         CHEMICAL ON THE FILE, THE PROGRAM PRINTS SUMMARY COUNTS
C         OF THE NUMBER OF PROPERTY ITEMS ACTUALLY USED BY THE MODELS,
C         BROKEN DOWN BY STATUS CODE.  NOTE THAT THESE SUMMARY COUNTS
C         ARE NOT THE SAME AS GIVEN BY THE PROPERTY RETRIEVAL PROGRAM
C         (WHICH REPORTS ON ALL ITEMS STORED, WHETHER OR NOT USED).
C
C         HDR     = HEADER, FIRST RECORD ON PROPERTY FILE, IDENTIFIES
C                     CURRENT AND PREVIOUS FILE VERSIONS
C         I       = LOOP INDEX
C         IBLNK   = DATA WORD SET TO BLANKS USED TO SKIP EMPTY MODEL
C                     CODES IN ASSESSMENT PATH DATA
C         IPTH    = PATH CODES FOR SINGLE CHEMICAL, UP TO 16 MODEL CODES
C                     INTERPRETED FROM INPUT ARRAY YPTH TO GIVE SINGLE
C                     ALPHABETIC MODEL CODE IN EACH WORD
C         IREQ    = CONTROLLING ARRAY FOR DATA GAP SCREEN FOR SINGLE
C                     CHEMICAL.  ELEMENT I IS INITIALIZED TO ZERO, THEN
C                     SET TO 1 IF ANY MODEL IN PATH CODE LIST FOR THE
C                     CHEMICAL USES PROPERTY ITEM I AS INPUT.
C         ITP     = FORTRAN UNIT REFERENCE NUMBER FOR INPUT PROPERTY
C                     TAPE FILE
C         J       = LOOP INDEX
C         K       = INDEX POINTER TO LINE OF ARRAY LIST FOR SINGLE
C                     MODEL CODE IN PATH LIST, OR ZERO IF MODEL DOES
C                     NOT REQUIRE PROPERTY DATA
C         LGAP    = SEQUENCE COUNT OF DATA GAPS FOUND FOR SINGLE CHEMICAL
C         LIST    = MASTER REFERENCE LIST ESTABLISHING EACH UNIQUE SET
C                     OF PROPERTY DATA ITEMS, CURRENTLY CONTAINS 14 SUB-
C                     LISTS OF 74 ELEMENTS EACH.  SOME SUB-LISTS ARE USED
C                     MORE THAN ONCE (FOR DIFFERENT MODELS).  ELEMENT I
C                     ON SUB-LIST IS SET TO 1 IF MODEL CORRESPONDING TO
C                     SUB-LIST USES PROPERTY ITEM I, OR IS ZERO OTHERWISE.
C         LP      = FORTRAN UNIT REFERENCE NUMBER FOR PRINTER
C         LREF    = ARRAY CONTAINING SUB-LIST INDEX NUMBER (TO ARRAY LIST)
C                     FOR EACH ALPHABETIC MODEL CODE, IN POSITION
C                     CORRESPONDING TO LOCATION OF MODEL CODE IN PTLST
C         NEST    = NUMBER OF REQUIRED PROPERTY ITEMS ON DATA FILE FOR
C                     WHICH THE CURRENT VALUE IS AN ESTIMATE
C         NEXT    = NUMBER OF REQUIRED PROPERTY ITEMS ON DATA FILE FOR
```

```
C                 WHICH THE CURRENT VALUE IS EXACT
C        NGAP   = NUMBER OF REQUIRED PROPERTY ITEMS ON DATA FILE FOR
C                 WHICH THE CURRENT VALUE IS MISSING
C        NTOT   = TOTAL NUMBER OF ITEMS ON PROPERTY FILE ACTUALLY
C                 USED BY HACS MODEL.
C        PBUF   = PRINT BUFFER, ELEMENTS 1 TO LGAP CONTAIN PROPERTY
C                 ITEM INDEX NUMBER OF EACH DATA GAP FOR SINGLE
C                 CHEMICAL
C        PTLST  = LIST OF ALL ALPHABETIC MODEL LETTER CODES WHICH CAN
C                 APPEAR IN PATH CODE FOR CHEMICAL
C        YCOD   = CHEMICAL RECOGNITION CODE READ FROM PROPERTY FILE
C        YNAM   = CHEMICAL NAME
C        YPTH   = ARRAY OF MODEL CODES READ ON INPUT FOR PATH CODE FOR
C                 PARTICULAR CHEMICAL.  CONVERSION FROM CDC 3300
C                 PRODUCES STORAGE OF MORE THAN ONE CODE PER WORD OF
C                 ARRAY.  CONVERSION IN THIS PROGRAM PRODUCES USFABLE
C                 LIST OF CODES IN ARRAY IPTH.
C        YTYP   = ARRAY OF STATUS CODES FOR EACH ITEM (1 TO 74) STORED
C                 ON PROPERTY FILE FOR SINGLE CHEMICAL (0=MISSING,
C                 2=ESTIMATE, 3=EXACT)
C        YVAL   = ARRAY USED FOR STORAGE OF NUMERIC VALUES OF PROPERTY
C                 ITEMS, REQUIRED HERE ONLY TO READ ENTIRE CHEMICAL
C                 DATA RECORD
C
C        COMMON VARIABLES USED - NONE
C
C        SUBROUTINES REQUIRED  - NONE
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.
C                             35/318A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C
C        DATE   - 03 JULY 1980
C
C
     0DIMENSION HDR(6),IPTH(16),IREQ(74),LIST(14,74),LREF(30),PBUF(74),
     1          PTLST(30),YNAM(5),YPTH(8),YTYP(74),YVAL(74)
      DIMENSION NEST(74),NEXT(74),NGAP(74),NTOT(74)
      INTEGER   HDR,PBUF,PTLST,YCOD,YTYP
      EQUIVALENCE (YCOD,YVAL(1))
C
      DATA IBLNK/4H    /,ITP/9/,LP/6/
C
     0DATA (LIST(1,I),I=1,74)/3*0,2*1,6*0,5*1,14*0,4*1,8*0,3*1,2*0,6*1,
     1                        0,1,19*0/
      DATA (LIST(2,I),I=1,74)/3*0,1,38*0,3*1,24*0,4*1,0/
      DATA (LIST(3,I),I=1,74)/3*0,1,56*0,1,2*0,1,10*0/
      DATA (LIST(4,I),I=1,74)/4*0,1,6*0,5*1,2*0,4*1,32*0,1,19*0/
      DATA (LIST(5,I),I=1,74)/3*0,2*1,6*0,5*1,26*0,3*1,17*0,1,9*0,1,0/
      DATA (LIST(6,I),I=1,74)/4*0,1,6*0,5*1,18*0,1,7*0,3*1,9*0,1,19*0/
      DATA (LIST(7,I),I=1,74)/3*0,2*1,0,1,4*0,5*1,22*0,1,0,5*1,29*0/
      DATA (LIST(8,I),I=1,74)/3*0,2*1,6*0,5*1,44*0,1,2*0,1,10*0/
      DATA (LIST(9,I),I=1,74)/3*0,2*1,0,1,4*0,5*1,58*0/
     0DATA (LIST(10,I),I=1,74)/3*0,2*1,0,1,4*0,5*1,26*0,3*1,15*0,1,2*0,
     1                        1,10*0/
     0DATA (LIST(11,I),I=1,74)/3*0,2*1,0,1,4*0,5*1,2*0,4*1,12*0,1,0,1,0,
     1                        1,0,2*1,32*0/
     0DATA (LIST(12,I),I=1,74)/3*0,2*1,6*0,5*1,2*0,4*1,8*0,4*1,2*0,1,
     1                        5*0,3*1,9*0,1,5*0,1,13*0/
      DATA (LIST(13,I),I=1,74)/3*0,1,7*0,5*1,44*0,1,2*0,1,10*0/
     0DATA (LIST(14,I),I=1,74)/3*0,2*1,0,1,4*0,5*1,20*0,1,0,1,0,2*1,
     1                        32*0/
C
     0DATA (LREF(I),I=1,30)/1,2,3,4,5,4,3,5,6,3,7,5,0,8,0,9,5,10,3,
     1                    11,5,12,13,14,6*0/
C
     0DATA (PTLST(I),I=1,30)/
     1      4HA    ,4HB    ,4HC    ,4HD    ,4HE    ,4HF    ,4HG    ,4HH    ,
     2      4HI    ,4HJ    ,4HK    ,4HL    ,4HM    ,4HN    ,4HO    ,4HP    ,
     3      4HQ    ,4HR    ,4HS    ,4HT    ,4HU    ,4HV    ,4HW    ,4HX    ,
     4      4HY    ,4HZ    ,4HII   ,4HRR   ,4HSS   ,4H     /
```

```
C
C
C--------INITIALIZE SUMMARY COUNTS
      DO 1 I=1,74
      NEST(I)=0
      NEXT(I)=0
      NGAP(I)=0
    1 NTOT(I)=0
C
C--------REWIND TAPE AND READ HEADER RECORD.  TERMINATE IF GET END FILE.
      REWIND ITP
      READ(ITP) HDR
      IF (EOF(ITP))5,30
C
C--------INITIAL END OF FILE ERROR CONDITION
    5 WRITE(LP,1010)
C--------NORMAL RETURN
   20 CONTINUE
C
C--------PRINT SUMMARY COUNTS OF REQUIRED DATA ITEMS
      WRITE(LP,1090)
      DO 25 I=4,74
      WRITE(LP,1100) I,NGAP(I),NEST(I),NEXT(I),NTOT(I)
      NGAP(1)=NGAP(1)+NGAP(I)
      NEST(1)=NEST(1)+NEST(I)
      NEXT(1)=NEXT(1)+NEXT(I)
   25 NTOT(1)=NTOT(1)+NTOT(I)
      WRITE(LP,1110) NGAP(1),NEST(1),NEXT(1),NTOT(1)
      REWIND ITP
      STOP
C
C--------PRINT REPORT TITLE AND DISPLAY FILE HEADER
   30 CONTINUE
      WRITE(LP,1120)
      WRITE(LP,1020) HDR(5),HDR(4),HDR(3),HDR(6),HDR(2),HDR(1)
C
C--------RETURN HERE TO READ NEXT PHYSICAL PROPERTY RECORD
   40 READ(ITP) YTYP,YVAL(1),YNAM,YPTH,(YVAL(I),I=4,74)
C
C--------TEST FOR END OF FILE.  STOP ON EOF.
      IF(EOF(ITP)) 20,50
C
C--------PROCESS CHEMICAL RECORD
   50 CONTINUE
C
C---------UNPACK PATH CODES AND STORE IN ARRAY IPTH
      DECODE(80,1040,YPTH) IPTH
C
C--------INITIALIZE ARRAY IREQ
      DO 60 I=1,74
   60 IREQ(I)=0
C
C--------LOOP THROUGH EACH MODEL CODE IN PATH READ FOR SINGLE CHEMICAL.
C        SKIP ALL BLANK MODEL CODES IN PATH.
      DO 100 I=1,16
      IF(IPTH(I).EQ.IBLNK) GO TO 100
C
C--------FOR EACH NON-BLANK MODEL CODE READ, USE LIST OF VALID CODES
C        TO TRANSLATE FROM LETTER CODE TO NUMERIC SUB-LIST INDEX K.
      K=0
      DO 70 J=1,29
      IF(IPTH(I).NE.PTLST(J)) GO TO 70
C--------FOUND MATCH, CROSS-REFERENCE FROM MODEL LETTER CODE TO
C        SUB-LIST OF REQUIRED PROPERTY DATA.
      K=LREF(J)
      GO TO 80
   70 CONTINUE
C
C--------NOTE - K=0 HERE IF MODEL DOES NOT USE PROPERTY DATA OR IF
C        MODEL CODE IS NOT DEFINED ON LIST.  SKIP IF NO DATA IS REQUIRED
C        FOR THIS MODEL.
   80 IF(K.EQ.0) GO TO 100
```

```
C
C--------SET EACH ELEMENT OF IREQ ARRAY TO 1 FOR EACH REQUIRED DATA
C         ITEM FOR THIS MODEL CODE.
      DO 90 J=1,74
      IF(LIST(K,J).GT.0) IREQ(J)=1
   90 CONTINUE
C
C--------CONTINUE LOOP FOR EACH MODEL CODE IN PATH
  100 CONTINUE
C
C--------FOR EACH REQUIRED DATA ITEM, CHECK STATUS CODE.  STORE INDEX
C         OF MISSING ITEMS IN ARRAY PBUF FOR PRINTING.
      LGAP=0
      DO 110 I=1,74
      IF(IREQ(I).EQ.0) GO TO 110
C--------COUNT TOTAL NUMBER OF DATA ITEMS ACTUALLY REQUIRED.
      NTOT(I)=NTOT(I)+1
C--------BRANCH ON STATUS CODE OF ITEM.  INCREMENT COUNTS OF EXACT AND
C         ESTIMATED ITEMS THEN CONTINUE IF VALUE IS NOT MISSING.
      IF(YTYP(I).EQ.3) NEXT(I)=NEXT(I)+1
      IF(YTYP(I).EQ.2) NEST(I)=NEST(I)+1
      IF(YTYP(I).GT.0) GO TO 110
C--------ITEM IS DATA GAP, STORE ITEM INDEX FOR PRINT DISPLAY
      NGAP(I)=NGAP(I)+1
      LGAP=LGAP+1
      PBUF(LGAP)=I
  110 CONTINUE
C
C--------SKIP IF NO DATA GAPS, OTHERWISE DISPLAY CHEMICAL ID FIRST.
C         PBUF DISPLAY IS FRAGMENTED TO AVOID UNNECESSARY BLANK LINES
C         IN OUTPUT OF VARIABLE LENGTH DATA WHICH MAY POSSIBLY EXCEED
C         LENGTH OF ONE OR TWO PRINT LINES.  AFTER DISPLAY, CYCLE
C         BACK FOR NEXT CHEMICAL OR EOF.
      IF(LGAP.EQ.0) GO TO 40
      WRITE(LP,1030) YCOD,YNAM,YPTH
  120 IF(LGAP.GT.30) GO TO 130
      WRITE(LP,1070) LGAP,(PBUF(I),I=1,LGAP)
      GO TO 40
  130 WRITE(LP,1070) LGAP,(PBUF(I),I=1,30)
      IF(LGAP.GT.60) GO TO 140
      WRITE(LP,1080) (PBUF(I),I=31,LGAP)
      GO TO 40
  140 WRITE(LP,1080) (PBUF(I),I=31,60)
      WRITE(LP,1080) (PBUF(I),I=61,LGAP)
      GO TO 40
C
 1010 FORMAT (/5X,46H*****ERROR - UNABLE TO READ HACS PROPERTY FILE)
 10200FORMAT (/10X,21HFILE OPENED HAS ID = ,A4,20H,  VERSION NUMBER = ,
     1 I5,10H,  DATE = ,I6/13X,18HBACK-UP FILE ID = ,A4,20H,  VERSION NU
     2MBER = ,I5,10H,  DATE = ,I6)
 1030 FORMAT (2X,A3,3X,5A8,3X,8A8)
 1040 FORMAT (8(2A4,2X))
 1070 FORMAT (5X,I2,20H DATA GAPS, ITEMS = ,30I3)
 1080 FORMAT (27X,30I3)
 10900FORMAT (////9X,39HHACS PHYSICAL PROPERTY DATA GAP SUMMARY/9X,
     1 39(1H-)//5X,44HFIELD    MISSING  ESTIMATED  EXACT     TOTAL/5X,
     2 46HNUMBER   VALUES    VALUES    VALUES   REQUIRED/5X,6(1H-),3X,
     3 7(1H-),2X,9(1H-),2X,6(1H-),3X,8(1H-))
 1100 FORMAT (7X,I2,4(5X,I5))
 1110 FORMAT (5X,6(1H-),4(3X,5(1H-),2X)/5X,5HTOTAL,4(3X,I6,1X)////)
 1120 FORMAT (5X,38HHACS PHYSICAL PROPERTY DATA GAP REPORT////)
      END
READY.
```

7.2 Message File Creation

Section 7.2 contains listings of three programs used to create the field text, scenario descriptions and model explanations. The original version of the program was created to process messages entered for HACS data field explanations; the following two versions were then created as special cases or simplifications. Corresponding to the file load programs in this section are three message display programs given in Section 7.3.

The programs used to create the field text message file were prepared to provide for coded messages, and control for either interactive or batch processing. This allows for both the initial file creation step, as well as any subsequent editing which may be desired.

The file of scenario text data was prepared as uncoded messages using a similar version of the program. However, the need for changing these messages is probably limited.

The file of model text data was prepared using a simplified version of the program to process model text input in batch mode only.

Note that maximum message lengths, number of messages, format control characters, and related message attributes are different among these three programs and resulting files.

7.2.1 Field Text (File RGPTXT)

```
0PROGRAM TXTLOD(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,
1               TAPE10,TAPE11,TAPE12)
C
C     PROGRAM LOADS A MASS STORAGE FILE WITH CODED MESSAGE
C     TEXT DATA, INDEXED BY MESSAGE NUMBER.  TWO MODES OF OPERATION
C     ARE PROVIDED: INTERACTIVE AND BATCH.  THE FILE IS INITIALLY
C     BUILT IN THE INTERACTIVE MODE IN WHICH A SERIES OF TEXT
C     MESSAGES ARE ADDED TO THE PREVIOUS CONTENTS OF THE MS FILE.
C     MESSAGES ARE ADDED IN SEQUENCE BY MESSAGE NUMBER IMMEDIATELY
C     FOLLOWING THE LAST MESSAGE PREVIOUSLY ENTERED.  INTERACTIVE
C     RUNS MAY BE TERMINATED AND RE-STARTED AT A LATER TIME UNTIL
C     THE FULL 256 MESSAGE FILE IS CREATED.  IN BATCH MODE, A TEXT
C     FILE, PRODUCED BY OUTPUT FROM A SEPARATE PROGRAM FOR ON-LINE
C     TEXT EDITING, CONTAINING THE FULL SET OF TEXT MESSAGES IS
C     PROCESSED FROM START TO FINISH.  IN GENERAL, ERRORS ENCOUNTERED
C     IN THE BATCH MODE ARE IMMEDIATELY FATAL, WHILE THE PROGRAM
C     PERMITS RECOVERY FROM MOST INTERACTIVE ERRORS.
C
C     THE HACS DEFAULT FILE IS READ BY THIS PROGRAM TO OBTAIN
C     FIELD NUMBERS, NAMES AND VARIABLE TYPES FOR USE IN DISPLAYS
C     AND TO CORRELATE THE SEQUENTIAL MESSAGE NUMBERS (FROM 1 TO 256)
C     WITH FIELD POSITIONS IN THE DEFAULT FILE.
C
C     THE MASS STORAGE FILE PRODUCED BY THIS PROGRAM CONTAINS
C     VARIABLE LENGTH RECORDS, INDEXED NUMERICALLY BY A MESSAGE
C     NUMBER WHICH RANGES FROM 1 TO 256.  A SINGLE RECORD IS CREATED
C     IN THE FILE FOR EACH MESSAGE NUMBER.  RECORDS IN THE FILE
C     ARE CODED AS FOLLOWS:
C
C          UNCODED - UNCODED RECORDS CONTAIN TEXT (SEE BELOW)
C          TYPE 1  - TYPE 1 RECORDS CONTAIN 3 WORDS OF 10 CHARACTERS
C                    TO CONSTRUCT THE MINIMUM RECORD SIZE FOR A
C                    CDC MS FILE.  THE FIRST WORD CONTAINS 1H1,
C                    FOLLOWED BY BLANKS; THE SECOND AND THIRD
C                    WORDS ARE ALSO BLANK.  TYPE 1 MESSAGES ARE
C                    STANDARDIZED IN HACS AS REFERENCES TO THE
C                    USER MANUAL.
C          TYPE 2  - THESE ARE SIMILAR TO TYPE 1 RECORDS, BUT
C                    CONTAIN 1H2 FOLLOWED BY BLANKS.  TYPE 2
C                    MESSAGES ARE STANDARDIZED IN HACS AS
C                    REFERENCES TO CHEMICAL PROPERTY DATA.
C          TYPE 3  - THESE ARE SPECIAL TYPE 2 RECORDS FOR WHICH
C                    ADDITIONAL TEXT IS ALSO GIVEN.  THE FIRST
C                    WORD OF THE RECORD CONTAINS 1H3 FOLLOWED BY
C                    BLANKS.  THE REMAINDER OF THE RECORD CONTAINS
C                    VARIABLE LENGTH TEXT.
C
C     TEXT CONTAINED IN UNCODED OR TYPE 3 RECORDS IS VARIABLE
C     LENGTH (RECORD LENGTH GE 3), AND PACKED AS 10 CHARACTERS
C     PER WORD.  RECORDS CONTAIN ONE OR MORE LINES OF MESSAGE
C     TEXT ORIGINALLY ENTERED VIA THIS PROGRAM IN INTERACTIVE MODE.
C     EMBEDDED BLANKS BETWEEN LINES ARE AUTOMATICALLY REMOVED, AND
C     FORTRAN FORMAT CODE FOR '/5X,' IS AUTOMATICALLY INSERTED
C     BETWEEN CHARACTER STRINGS REPRESENTING DIFFERENT LINES.  WHEN
C     USED BY HACS, THE MESSAGE DATA IS READ INTO AN ARRAY AND
C     FORMAT CODE APPENDED TO THE BEGINNING AND END OF THE ARRAY.
C     THE EXPANDED ARRAY IS THEN USED AS AN EXECUTION TIME FORMAT
C     TO PRODUCE THE DESIRED MESSAGE.  THIS PROCEDURE IS ILLUSTRATED
C     IN THE AUDIT PORTION OF THE PROGRAM BELOW.
C
C     SINCE THE MESSAGE TEXT IS STORED AND USED AS PACKED CHARACTER
C     DATA, THIS PROGRAM IS SIGNIFICANTLY MACHINE DEPENDENT.  OUTPUT
C     PRODUCED BY THIS PROGRAM IS WRITTEN AS 10 CHARACTER WORDS.  IN
C     ADDITION TO THE USE OF OPEN, WRITE AND CLOSE MASS STORAGE
C     UTILITY SUBROUTINES, THE CDC ENCODE FUNCTION IS USED TO
C     PACK MESSAGE DATA READ IN A1 FORMAT TO A10 FORMAT FOR OUTPUT
C     TO THE MS FILE.
```

```
C
C
C        BUFF   = A10 STORAGE FOR USER RESPONSE TO VERIFICATION QUERY.
C                   ANY RESPONSE OTHER THAN CARRIAGE RETURN REJECTS
C                   MESSAGE INPUT.
C        DEFLT  = EXTERNAL HACS DEFAULT FILE, READ TO OBTAIN HACS
C                   FIELD NUMBER, FIELD NAME AND FIELD TYPE (INTEGER
C                   OR REAL) CORRESPONDING TO SEQUENTIAL FIELD
C                   MESSAGE NUMBERS.
C        FORM   = SIX-WORD ARRAY CONTAINING FORMAT CODE TO BE INSERTED
C                   BETWEEN EACH LINE OF MULTIPLE LINE MESSAGES.
C        FPCK   = ARRAY EQUIVALENCED TO PACKED MESSAGE TEXT, AND CON-
C                   TAINING STANDARD FORMAT CODE IN FIRST WORD
C        FVAL   = ARRAY OF DEFAULT VALUES, MINIMUM AND MAXIMUM FOR
C                   REAL HACS DATA FIELDS.  READ AS PART OF DEFAULT
C                   FILE BUT NOT OTHERWISE USED IN THIS PROGRAM.
C        I      = GENERAL LOOP INDEX
C        IO     = FIRST CHARACTER OF ARRAY TEXT FOR START OF PACK INTO
C                   ARRAY PACK, SET TO 1 FOR UNCODED MESSAGES OR TO 2
C                   FOR TYPE 3 MESSAGES.
C        IBLNK  = DATA WORD SET TO ALL BLANKS FOR USE IN INITIALIZING
C                   CHARACTER VARIABLES
C        IBTCH  = DEVICE NUMBER FOR BATCH INPUT FILE WHEN RUNNING IN
C                   BATCH MODE
C        IN     = INPUT DEVICE NUMBER SET TO EITHER TTY OR IBTCH VIA
C                   USER CONTROL AT START OF RUN
C        ISTRT  = INDEX NUMBER OF LAST MESSAGE PREVIOUSLY LOADED ONTO
C                   MASS STORAGE FILE.  EACH RUN OF PROGRAM IN THE
C                   INTERACTIVE MODE ADDS MESSAGES SEQUENTIALLY BY 1
C                   FROM ISTRT+1 UP TO A MAXIMUM OF 256.  IN BATCH
C                   MODE, A BULK RE-CREATION OF THE MS FILE BUILDS ALL
C                   MESSAGES FROM 1 TO 256.
C        ISW    = CONTROL FLAG SET TO 0 FOR INTERACTIVE INPUT, OR TO
C                   1 FOR BATCH INPUT.
C        IVAL   = ARRAY OF DEFAULT VALUES, MINIMUM AND MAXIMUM FOR
C                   INTEGER HACS DATA FIELDS.  READ AS PART OF DEFAULT
C                   FILE BUT NOT OTHERWISE USED IN THIS PROGRAM.
C        IVAR   = CODED FIELD TYPE INDICATOR PACKED IN ARRAY LIST FOR
C                   EACH HACS DATA FIELD (0=INTEGER FIELD, 1=REAL FIELD)
C        J      = GENERAL LOOP INDEX
C               = INDEX TO LAST NON-BLANK CHARACTER READ ON SINGLE
C                   MESSAGE LINE
C               = WORD INDEX TO ARRAY PACK, AND LENGTH OF FINAL PACKED
C                   MESSAGE TEXT (IN WORDS)
C        JP     = DUMMY INDEX, SET TO J+1, USED TO STORE FORMAT
C                   TERMINATOR IN PACKED MESSAGE TEXT FOR DISPLAY
C                   BUT NOT OUTPUT TO MS FILE.
C        LEN    = COUNT OF CHARACTERS IN TEXT TO BE MOVED TO ARRAY
C                   PACK IN A10 FORMAT
C        LINE   = BUFFER USED FOR STORAGE OF SINGLE INPUT LINE OF
C                   MESSAGE TEXT IN A1 FORMAT.  LENGTH SET TO 130
C                   CHARACTERS FOR USE WITH WIDE-BODY TERMINALS, HOWEVER
C                   ACTUAL MESSAGE LENGTH IS LIMITED TO 70 CHARACTERS
C                   PER LINE.
C        LIST   = ARRAY OF CODES IN HACS DEFAULT FILE DEFINING
C                   STRUCTURE OF DATA FIELD ITEM I AS LIST(I,J) WHERE
C                   J=1,6.  LIST(I,1) GIVES FIELD NUMBER FOR FIELD I
C                   AND LIST(I,J),J=3,5, GIVES FIELD NAME.  ELEMENT 2
C                   CONTAINS CODED SOURCE CODE, VARIABLE TYPE AND
C                   QUANTITY TYPE.  ELEMENT 6 IS INDEX TO STORAGE
C                   OF NUMERIC VALUES IN FVAL OR IVAL.  REFER TO HACS
C                   PROGRAM DOCUMENTATION FOR COMPLETE DETAILS.
C        LP     = UNIT DEVICE FOR PROGRAM OUTPUT IN EITHER BATCH OR
C                   INTERACTIVE MODES
C        M      = COUNT OF TOTAL NUMBER OF MESSAGE CHARACTERS
C                   ACCUMULATED IN ARRAY TEXT
C        MNF    = MAXIMUM NUMBER OF REAL FIELD ITEMS ALLOWED IN HACS
C                   DEFAULT FILE.  READ FROM DEFAULT FILE BUT NOT
C                   OTHERWISE USED IN THIS PROGRAM.
C        MNI    = MAXIMUM NUMBER OF INTEGER FIELD ITEMS ALLOWED IN HACS
C                   DEFAULT FILE.  READ FROM DEFAULT FILE BUT NOT
C                   OTHERWISE USED IN THIS PROGRAM.
```

```
C        MOD    = DATA WORD CONTAINING LABELS USED IN MESSAGE INPUT
C                   PROMPT DISPLAY FOR REAL OR INTEGER FIELDS.
C        MSG    = TEXT LABEL STORED AS PART OF DEFAULT FILE
C        NDEX   = FILE TABLE USED BY MASS STORAGE ROUTINES, DIMENSIONED
C                   TO NUMBER OF TEXT MESSAGES + 1
C        NF     = ACTUAL NUMBER OF REAL DATA FIELDS CONTAINED IN HACS
C                   DEFAULT FILE
C        NFLD   = TOTAL NUMBER OF DATA FIELDS STORED IN HACS DEFAULT
C                   FILE (=NF+NI).  DEFINITIONS OF EACH MESSAGE ARE
C                   STORED SEQUENTIALLY IN ARRAY LIST.
C        NI     = ACTUAL NUMBER OF INTEGER DATA FIELDS CONTAINED IN HACS
C                   DEFAULT FILE
C        NLIN   = LINE COUNTER, USED TO LIMIT MULTIPLE LINE TEXT
C                   MESSAGES TO NOT MORE THAN 9 LINES OF TEXT FOLLOWED
C                   BY SINGLE BLANK LINE AS A DELIMITER.
C        ONE    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 1
C        PACK   = ARRAY CONTAINING PACKED MESSAGE TEXT DATA TO BE
C                   WRITTEN TO MS FILE.
C        TERM   = DATA WORD CONTAINING CHARACTERS TO CLOSE MESSAGE
C                   IN PACK FOR USE AS EXECUTION TIME FORMAT
C        TEXT   = ARRAY USED TO ACCUMULATE MESSAGE LINE INPUT AND
C                   FORMAT CONTROL LINE SEPARATION CHARACTERS IN
C                   SINGLE CHARACTER (A1) FORMAT.  ALL EMBEDDED BLANKS
C                   BETWEEN LINES ARE REMOVED BEFORE PACKING.
C        THR    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 3
C        TTY    = DEVICE NUMBER USED FOR INPUT UNIT WHEN RUNNING IN
C                   INTERACTIVE MODE
C        TWO    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 2
C        UDFLT  = UNIT DEVICE NUMBER FOR EXTERNAL HACS DEFAULT FILE
C        UTXT   = UNIT DEVICE NUMBER FOR EXTERNAL MS MESSAGE TEXT FILE
C        ZER    = DATA WORD CONTAINING TAG USED TO TEST FOR USER
C                   TERMINATION OF INTERACTIVE TERMINAL SESSION.
C
C        AUTHOR - R.G. POTTS
C                 ARTHUR D. LITTLE, INC.
C                 35/318A ACORN PARK
C                 CAMBRIDGE, MASS.  02140
C                 TEL. 617-864-5770,  EXT. 2813
C
C        DATE   - 22 JULY 1980
C
C
      OCOMMON/BASE/MSG(10),MNF,MNI,NF,NI,LIST(275,6),
     1           FVAL(225,3),IVAL(50,3)
       REAL         MSG
       DIMENSION    DEFLT(2489)
       EQUIVALENCE  (DEFLT(1),MSG(1))
C
C
      ODIMENSION    FORM(6),FPCK(71),LINE(130),MOD(2,2),NDEX(257),
     1              PACK(70),TEXT(684)
      OINTEGER      BUFF,FORM,FPCK,ONE,PACK,TERM,TEXT,THR,TTY,TWO,
     1              UDFLT,UTXT,ZER
       EQUIVALENCE  (FPCK(2),PACK(1))
       DATA         (FORM(I),I=1,6)/1H',1H/,1H5,1HX,1H,,1H'/
       DATA         FPCK(1)/10H(5X,      '/,IBLNK/1H /,IBTCH/12/,LP/6/
      ODATA         MOD(1,1)/4HINTE/,MOD(1,2)/3HGER/,MOD(2,1)/4HREAL/,
     1              MOD(2,2)/1H /,ONE/1H1/,TERM/2H')/,THR/1H3/,TTY/5/,
     2              TWO/1H2/,UDFLT/10/,UTXT/11/,ZER/1H0/
C
C
C--------SELECT BATCH OR INTERACTIVE INPUT UNIT
   10 WRITE(TTY,1000)
      IF(EOF(TTY)) 20,20
   20 READ(TTY,1010) ISW
      IF(ISW.EQ.0) GO TO 30
      IF(ISW.NE.1) GO TO 10
      IN=IBTCH
      GO TO 40
   30 IN=TTY
   40 CONTINUE
C
```

```
C--------READ EXTERNAL DEFAULT FILE CONTAINING FIELD NUMBERS AND
C        NAMES INDEXED SEQUENTIALLY.
      REWIND UDFLT
      READ(UDFLT) DEFLT
C
C--------PROGRAM ASSUMES DEFAULT FILE CONTAINS EXACTLY 256 ENTRIES.
      NFLD=NF+NI
      IF(NFLD.EQ.256) GO TO 50
      WRITE(LP,1020)
      STOP
   50 CONTINUE
C
C--------OPEN MASS STORAGE MESSAGE FILE, INDEXED BY MESSAGE NUMBER
      CALL OPENMS(UTXT,NDEX,257,0)
C
C--------READ AND VALIDATE NUMBER OF LAST MESSAGE ENTERED TO INITIALIZE
C        START OF SEQUENCE.
   60 IF(ISW.EQ.0) WRITE(TTY,1030)
      IF(EOF(IN)) 70,70
   70 READ(IN,1040) ISTRT
      IF(ISTRT.LT.0) GO TO 80
      IF(ISTRT.LE.256) GO TO 90
   80 WRITE(LP,1050)
      IF(ISW.EQ.0) GO TO 60
      STOP
   90 CONTINUE
C
C--------START OF EACH NEW CYCLE FOR NEXT MESSAGE.  CLOSE FILE AND STOP
C        AFTER 256 MESSAGES ARE STORED.
  100 ISTRT=ISTRT+1
      IF(ISTRT.LE.256) GO TO 120
  110 CALL CLOSMS(UTXT)
      STOP
  120 CONTINUE
C
C--------READ SINGLE LINE FROM BATCH INPUT FILE (SKIP FOR INTERACTIVE
C        INPUT).  LINE IN FILE GIVES MESSAGE NUMBER, HACS FIELD NUMBER
C        AND HACS FIELD NAME FOR REFERENCE USE.  ONLY THE MESSAGE
C        NUMBER IS READ AND MUST MATCH THE SEQUENCE COUNT ISTRT.
      IF(ISW.EQ.0) GO TO 130
      READ(IN,1040) NMSG
      IF(NMSG.EQ.ISTRT) GO TO 130
      WRITE(LP,1060) NMSG
      STOP
C
C--------WRITE PROMPT DISPLAY FOR EITHER INTERACTIVE OR BATCH INPUT
C        GIVING THE MESSAGE NUMBER, FIELD MODE, NUMBER AND NAME.
  130 IVAR=LIST(ISTRT,2)/1000
      IVAR=IVAR+1
     0WRITE(LP,1070) ISTRT,(MOD(IVAR,I),I=1,2),LIST(ISTRT,1),
     1 (LIST(ISTRT,J),J=3,5)
C
C--------INITIALIZE FOR ACCUMULATION OF MULTIPLE LINE MESSAGES
      M=0
      DO 140 I=1,684
  140 TEXT(I)=IBLNK
      DO 150 I=1,70
  150 PACK(I)=IBLNK
      NLIN=0
C
C--------RETURN HERE TO READ EACH NEW LINE OF MULTIPLE LINE MESSAGE,
C        OR BLANK LINE TERMINATING MESSAGE.  INITIALIZE.
  160 NLIN=NLIN+1
  170 DO 180 I=1,130
  180 LINE(I)=IBLNK
C
C--------READ INPUT LINE OF UP TO 130 CHARACTERS IN A1 FORMAT.  THE
C        FORMAT FOR INTERACTIVE INPUT SUPPRESSES LEADING SPACES.  FOR
C        BATCH INPUT, THE TEXT IS PRECEDED BY FIVE SPACES SINCE THE
C        BATCH FILE CREATED FOR EDITING IS PREPARED BY EXECUTING THE
C        PREVIOUS MESSAGES AS FORMAT STATEMENTS.
      IF(EOF(IN)) 190,190
```

```
  190 CONTINUE
      IF(ISW.EQ.0) READ(IN,1080) LINE
      IF(ISW.EQ.1) READ(IN,1090) LINE
C
C--------LOCATE THE LAST NON-BLANK CHARACTER READ ON THE INPUT LINE.
      DO 200 I=1,130
      J=131-I
      IF(LINE(J).NE.IBLNK) GO TO 210
  200 CONTINUE
      J=0
  210 CONTINUE
C
C--------J GIVES THE INDEX TO THE LAST NON-BLANK CHARACTER READ ON
C           INPUT.  VALID TEXT LINES MAY BE BLANK IF NOT THE FIRST LINE,
C           AND MAY NOT CONTAIN MORE THAN 70 CHARACTERS OF TEXT.
      IF(J.LE.70) GO TO 220
C
C--------SINGLE LINE OVERFLOW.
      WRITE(LP,1100) NLIN
      IF(ISW.EQ.1) STOP
      GO TO 170
C
C--------TEST FOR LAST LINE (BLANK) TERMINATING MESSAGE.
  220 IF(J.GT.0) GO TO 230
C
C--------IF BLANK LINE IS PRECEDED BY TEXT, HAVE VALID END OF MESSAGE.
C           BRANCH TO PROCESS.  OTHERWISE, HAVE ERROR.
      IF(M.GT.0) GO TO 270
      WRITE(LP,1110)
      IF(ISW.EQ.1) STOP
      GO TO 170
C
C--------GET HERE WITH MESSAGE TEXT ENTERED FOR SINGLE LINE.  TEXT
C           MESSAGES ARE ALLOWED FOR UP TO 9 NON-BLANK LINES OF TEXT.  AN
C           ERROR OCCURS IF MORE THAN 9 LINES ARE ENTERED.
  230 IF(NLIN.LE.9) GO TO 240
      WRITE(LP,1120)
      IF(ISW.EQ.1) STOP
      GO TO 130
C
C--------APPEND NEW LINE OF TEXT TO ACCUMULATED MESSAGE TEXT, INSERT
C           OUTPUT FORMAT CONTROL AT END OF EACH NEW LINE, THEN RETURN TO
C           READ NEXT TEXT LINE OR BLANK DELIMITER.
  240 DO 250 I=1,J
      M=M+1
  250 TEXT(M)=LINE(I)
      DO 260 I=1,6
      M=M+1
  260 TEXT(M)=FORM(I)
      GO TO 160
C
C--------BLANK LINE HAS BEEN READ TERMINATING VALID MESSAGE.  REMOVE
C           LAST FORMAT CONTROL IN TEXT.
  270 DO 280 I=1,6
      TEXT(M)=IBLNK
  280 M=M-1
C
C--------CHECK FOR CODES IN MESSAGE TEXT.  0 TERMINATES THE RUN, AND
C           CODES 1 AND 2 PRODUCE BLANK (NULL) MESSAGES.
      IF(TEXT(1).EQ.ZER) GO TO 110
      IF(TEXT(1).EQ.ONE) GO TO 300
      IF(TEXT(1).EQ.TWO) GO TO 300
C
C--------MESSAGE IS EITHER UNCODED, OR CODED AS 3.  IF MESSAGE IS
C           UNCODED, PACK 1 TO M CHARACTERS FROM TEXT INTO WORDS 1 TO J
C           OF ARRAY PACK.  IF MESSAGE IS CODED AS 3, SET PACK(1) TO CODE
C           THEN PACK 2 TO M CHARACTERS FROM TEXT INTO WORDS 2 TO J OF
C           PACK.  MOVE TO AUDIT AND FILE UPDATE WHEN DONE.
      IF(TEXT(1).EQ.THR) GO TO 290
      IO=1
      LEN=M
      J=LEN+9
```

```
      J=J/10
      GO TO 295
  290 IO=2
      LEN=M-1
      J=LEN+9
      J=J/10
      J=J+1
      PACK(1)=TEXT(1)
      IF(M.GT.1) GO TO 295
      WRITE(LP,1110)
      IF(ISW.EQ.1) STOP
      GO TO 130
  295 ENCODE(LEN,1130,PACK(IO)) (TEXT(I),I=IO,M)
C
C--------PACKED MESSAGE LENGTH CANNOT BE LESS THAN MINIMUM RECORD LENGTH
      IF(J.GE.3) GO TO 310
      WRITE(LP,1135)
      IF(ISW.EQ.1) STOP
      GO TO 130
C
C--------PREPARE OUTPUT FOR MESSAGES CODED AS 1 OR 2.  CODE WORD IS
C           FOLLOWED BY TWO BLANK WORDS FOR MINIMUM MESSAGE LENGTH OF 3
C           WORDS.
  300 J=3
      PACK(1)=TEXT(1)
      PACK(2)=IBLNK
      PACK(3)=IBLNK
C
C--------DISPLAY MESSAGE FROM PACKED, CODED FORMAT
  310 IF(PACK(1).EQ.ONE) GO TO 320
      IF(PACK(1).EQ.TWO) GO TO 320
      IF(PACK(1).EQ.THR) GO TO 320
      WRITE(LP,1140)
      JP=J+1
      PACK(JP)=TERM
      WRITE(LP,FPCK)
      GO TO 330
  320 WRITE(LP,1150) PACK(1)
      IF(PACK(1).NE.THR) GO TO 330
      JP=J+1
      PACK(JP)=TERM
      PACK(1)=FPCK(1)
      WRITE(LP,PACK)
      PACK(1)=THR
C
C--------AFTER AUDIT, IN INTERACTIVE MODE, QUERY USER FOR VERIFICATION.
C           ANY NON-BLANK RESPONSE CANCELS MESSAGE.
  330 IF(ISW.EQ.1) GO TO 350
      WRITE(LP,1160)
      BUFF=IBLNK
      IF(EOF(IN)) 340,340
  340 READ(IN,1170) BUFF
      IF(BUFF.NE.IBLNK) GO TO 130
C
C--------WRITE MESSAGE TO OUTPUT FILE, THEN REPEAT ENTIRE PROCESS
C           FOR NEXT MESSAGE, UP TO 256 MESSAGES.
  350 CALL WRITMS(UTXT,PACK,J,ISTRT)
      GO TO 100
C
 1000 FORMAT (//40H  HACS DATA FIELD MESSAGE UPDATE PROGRAM//47H  ENTER
     10 FOR INTERACTIVE OR 1 FOR BATCH INPUT:)
 1010 FORMAT (I1)
 1020 FORMAT (5X,54H*****ERROR - DEFAULT FILE DOES NOT CONTAIN 256 ENTRI
     1ES)
 1030 FORMAT (//50H  ENTER NUMBER OF LAST MESSAGE SAVED IN I3 FORMAT:)
 1040 FORMAT (I3)
 1050 FORMAT (5X,54H*****ERROR - LAST MESSAGE NUMBER NOT IN RANGE 0 TO 2
     156)
 1060 FORMAT (5X,21H*****ERROR - MESSAGE ,I3,33H IS OUT OF SEQUENCE ON I
     1NPUT FILE)
 1070 FORMAT (/5X,34HENTER 0 OR CODED TEXT FOR MESSAGE ,I3,2H, ,A4,A3,
     1 7H FIELD ,I4,2X,3A4,1H:/)
```

```
 1080 FORMAT (130A1)
 1090 FORMAT (5X,130A1)
 11000FORMAT (5X,18H*****ERROR - LINE ,I2,48H EXCEEDS LENGTH OF 70 CHARA
     1CTERS. RE-ENTER LINE.)
 11100FORMAT (5X,68H*****ERROR - MESSAGE NOT FOUND. ENTER TEXT FOLLOWED
     1BY A BLANK LINE.)
 11200FORMAT (5X,73H*****ERROR - MESSAGE EXCEEDS MAXIMUM LENGTH OF 9 LIN
     1ES. RE-ENTER MESSAGE.)
 1130 FORMAT (684A1)
 11350FORMAT (5X,82H*****ERROR - MESSAGE TOO SHORT (MINIMUM LENGTH = 21
     1CHARACTERS). RE-ENTER MESSAGE.)
 1140 FORMAT (5X,24HMESSAGE IS UNCODED TEXT:/)
 1150 FORMAT (5X,25HMESSAGE IS CODED AS TYPE ,A1/)
 1160 FORMAT (4H OK?)
 1170 FORMAT (A10)
      END
READY.
```

7.2.2 Scenario Text (File RPSTXT)

```
0PROGRAM TXTLOD(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,
1                TAPE10,TAPE11,TAPE12)
C
C     PROGRAM LOADS A MASS STORAGE FILE WITH CODED MESSAGE
C     TEXT DATA, INDEXED BY MESSAGE NUMBER.  TWO MODES OF OPERATION
C     ARE PROVIDED: INTERACTIVE AND BATCH.  THE FILE IS INITIALLY
C     BUILT IN THE INTERACTIVE MODE IN WHICH A SERIES OF TEXT
C     MESSAGES ARE ADDED TO THE PREVIOUS CONTENTS OF THE MS FILE.
C     MESSAGES ARE ADDED IN SEQUENCE BY MESSAGE NUMBER IMMEDIATELY
C     FOLLOWING THE LAST MESSAGE PREVIOUSLY ENTERED.  INTERACTIVE
C     RUNS MAY BE TERMINATED AND RE-STARTED AT A LATER TIME UNTIL
C     THE FULL 256 MESSAGE FILE IS CREATED.  IN BATCH MODE, A TEXT
C     FILE, PRODUCED BY OUTPUT FROM A SEPARATE PROGRAM FOR ON-LINE
C     TEXT EDITING, CONTAINING THE FULL SET OF TEXT MESSAGES IS
C     PROCESSED FROM START TO FINISH.  IN GENERAL, ERRORS ENCOUNTERED
C     IN THE BATCH MODE ARE IMMEDIATELY FATAL, WHILE THE PROGRAM
C     PERMITS RECOVERY FROM MOST INTERACTIVE ERRORS.
C
C     THE HACS DEFAULT FILE IS READ BY THIS PROGRAM TO OBTAIN
C     FIELD NUMBERS, NAMES AND VARIABLE TYPES FOR USE IN DISPLAYS
C     AND TO CORRELATE THE SEQUENTIAL MESSAGE NUMBERS (FROM 1 TO 256)
C     WITH FIELD POSITIONS IN THE DEFAULT FILE.
C
C     THE MASS STORAGE FILE PRODUCED BY THIS PROGRAM CONTAINS
C     VARIABLE LENGTH RECORDS, INDEXED NUMERICALLY BY A MESSAGE
C     NUMBER WHICH RANGES FROM 1 TO 256.  A SINGLE RECORD IS CREATED
C     IN THE FILE FOR EACH MESSAGE NUMBER.  RECORDS IN THE FILE
C     ARE CODED AS FOLLOWS:
C
C          UNCODED - UNCODED RECORDS CONTAIN TEXT (SEE BELOW)
C          TYPE 1  - TYPE 1 RECORDS CONTAIN 3 WORDS OF 10 CHARACTERS
C                    TO CONSTRUCT THE MINIMUM RECORD SIZE FOR A
C                    CDC MS FILE.  THE FIRST WORD CONTAINS 1H1,
C                    FOLLOWED BY BLANKS; THE SECOND AND THIRD
C                    WORDS ARE ALSO BLANK.  TYPE 1 MESSAGES ARE
C                    STANDARDIZED IN HACS AS REFERENCES TO THE
C                    USER MANUAL.
C          TYPE 2  - THESE ARE SIMILAR TO TYPE 1 RECORDS, BUT
C                    CONTAIN 1H2 FOLLOWED BY BLANKS.  TYPE 2
C                    MESSAGES ARE STANDARDIZED IN HACS AS
C                    REFERENCES TO CHEMICAL PROPERTY DATA.
C          TYPE 3  - THESE ARE SPECIAL TYPE 2 RECORDS FOR WHICH
C                    ADDITIONAL TEXT IS ALSO GIVEN.  THE FIRST
C                    WORD OF THE RECORD CONTAINS 1H3 FOLLOWED BY
C                    BLANKS.  THE REMAINDER OF THE RECORD CONTAINS
C                    VARIABLE LENGTH TEXT.
C
C     TEXT CONTAINED IN UNCODED OR TYPE 3 RECORDS IS VARIABLE
C     LENGTH (RECORD LENGTH GE 3), AND PACKED AS 10 CHARACTERS
C     PER WORD.  RECORDS CONTAIN ONE OR MORE LINES OF MESSAGE
C     TEXT ORIGINALLY ENTERED VIA THIS PROGRAM IN INTERACTIVE MODE.
C     EMBEDDED BLANKS BETWEEN LINES ARE AUTOMATICALLY REMOVED, AND
C     FORTRAN FORMAT CODE FOR '/5X,' IS AUTOMATICALLY INSERTED
C     BETWEEN CHARACTER STRINGS REPRESENTING DIFFERENT LINES.  WHEN
C     USED BY HACS, THE MESSAGE DATA IS READ INTO AN ARRAY AND
C     FORMAT CODE APPENDED TO THE BEGINNING AND END OF THE ARRAY.
C     THE EXPANDED ARRAY IS THEN USED AS AN EXECUTION TIME FORMAT
C     TO PRODUCE THE DESIRED MESSAGE.  THIS PROCEDURE IS ILLUSTRATED
C     IN THE AUDIT PORTION OF THE PROGRAM BELOW.
C
C     SINCE THE MESSAGE TEXT IS STORED AND USED AS PACKED CHARACTER
C     DATA, THIS PROGRAM IS SIGNIFICANTLY MACHINE DEPENDENT.  OUTPUT
C     PRODUCED BY THIS PROGRAM IS WRITTEN AS 10 CHARACTER WORDS.  IN
C     ADDITION TO THE USE OF OPEN, WRITE AND CLOSE MASS STORAGE
C     UTILITY SUBROUTINES, THE CDC ENCODE FUNCTION IS USED TO
C     PACK MESSAGE DATA READ IN A1 FORMAT TO A10 FORMAT FOR OUTPUT
C     TO THE MS FILE.
```

```
C
C
C        BUFF   = A10 STORAGE FOR USER RESPONSE TO VERIFICATION QUERY.
C                    ANY RESPONSE OTHER THAN CARRIAGE RETURN REJECTS
C                    MESSAGE INPUT.
C        DEFLT  = EXTERNAL HACS DEFAULT FILE, READ TO OBTAIN HACS
C                    FIELD NUMBER, FIELD NAME AND FIELD TYPE (INTEGER
C                    OR REAL) CORRESPONDING TO SEQUENTIAL FIELD
C                    MESSAGE NUMBERS.
C        FORM   = SIX-WORD ARRAY CONTAINING FORMAT CODE TO BE INSERTED
C                    BETWEEN EACH LINE OF MULTIPLE LINE MESSAGES.
C        FPCK   = ARRAY EQUIVALENCED TO PACKED MESSAGE TEXT, AND CON-
C                    TAINING STANDARD FORMAT CODE IN FIRST WORD
C        FVAL   = ARRAY OF DEFAULT VALUES, MINIMUM AND MAXIMUM FOR
C                    REAL HACS DATA FIELDS.  READ AS PART OF DEFAULT
C                    FILE BUT NOT OTHERWISE USED IN THIS PROGRAM.
C        I      = GENERAL LOOP INDEX
C        IO     = FIRST CHARACTER OF ARRAY TEXT FOR START OF PACK INTO
C                    ARRAY PACK, SET TO 1 FOR UNCODED MESSAGES OR TO 2
C                    FOR TYPE 3 MESSAGES.
C        IBLNK  = DATA WORD SET TO ALL BLANKS FOR USE IN INITIALIZING
C                    CHARACTER VARIABLES
C        IBTCH  = DEVICE NUMBER FOR BATCH INPUT FILE WHEN RUNNING IN
C                    BATCH MODE
C        IN     = INPUT DEVICE NUMBER SET TO EITHER TTY OR IBTCH VIA
C                    USER CONTROL AT START OF RUN
C        ISTRT  = INDEX NUMBER OF LAST MESSAGE PREVIOUSLY LOADED ONTO
C                    MASS STORAGE FILE.  EACH RUN OF PROGRAM IN THE
C                    INTERACTIVE MODE ADDS MESSAGES SEQUENTIALLY BY 1
C                    FROM ISTRT+1 UP TO A MAXIMUM OF 256.  IN BATCH
C                    MODE, A BULK RE-CREATION OF THE MS FILE BUILDS ALL
C                    MESSAGES FROM 1 TO 256.
C        ISW    = CONTROL FLAG SET TO 0 FOR INTERACTIVE INPUT, OR TO
C                    1 FOR BATCH INPUT.
C        IVAL   = ARRAY OF DEFAULT VALUES, MINIMUM AND MAXIMUM FOR
C                    INTEGER HACS DATA FIELDS.  READ AS PART OF DEFAULT
C                    FILE BUT NOT OTHERWISE USED IN THIS PROGRAM.
C        IVAR   = CODED FIELD TYPE INDICATOR PACKED IN ARRAY LIST FOR
C                    EACH HACS DATA FIELD (0=INTEGER FIELD, 1=REAL FIELD)
C        J      = GENERAL LOOP INDEX
C               = INDEX TO LAST NON-BLANK CHARACTER READ ON SINGLE
C                    MESSAGE LINE
C               = WORD INDEX TO ARRAY PACK, AND LENGTH OF FINAL PACKED
C                    MESSAGE TEXT (IN WORDS)
C        JP     = DUMMY INDEX, SET TO J+1, USED TO STORE FORMAT
C                    TERMINATOR IN PACKED MESSAGE TEXT FOR DISPLAY
C                    BUT NOT OUTPUT TO MS FILE.
C        LEN    = COUNT OF CHARACTERS IN TEXT TO BE MOVED TO ARRAY
C                    PACK IN A10 FORMAT
C        LINE   = BUFFER USED FOR STORAGE OF SINGLE INPUT LINE OF
C                    MESSAGE TEXT IN A1 FORMAT.  LENGTH SET TO 130
C                    CHARACTERS FOR USE WITH WIDE-BODY TERMINALS, HOWEVER
C                    ACTUAL MESSAGE LENGTH IS LIMITED TO 70 CHARACTERS
C                    PER LINE.
C        LIST   = ARRAY OF CODES IN HACS DEFAULT FILE DEFINING
C                    STRUCTURE OF DATA FIELD ITEM I AS LIST(I,J) WHERE
C                    J=1,6.  LIST(I,1) GIVES FIELD NUMBER FOR FIELD I
C                    AND LIST(I,J),J=3,5, GIVES FIELD NAME.  ELEMENT 2
C                    CONTAINS CODED SOURCE CODE, VARIABLE TYPE AND
C                    QUANTITY TYPE.  ELEMENT 6 IS INDEX TO STORAGE
C                    OF NUMERIC VALUES IN FVAL OR IVAL.  REFER TO HACS
C                    PROGRAM DOCUMENTATION FOR COMPLETE DETAILS.
C        LP     = UNIT DEVICE FOR PROGRAM OUTPUT IN EITHER BATCH OR
C                    INTERACTIVE MODES
C        M      = COUNT OF TOTAL NUMBER OF MESSAGE CHARACTERS
C                    ACCUMULATED IN ARRAY TEXT
C        MNF    = MAXIMUM NUMBER OF REAL FIELD ITEMS ALLOWED IN HACS
C                    DEFAULT FILE.  READ FROM DEFAULT FILE BUT NOT
C                    OTHERWISE USED IN THIS PROGRAM.
C        MNI    = MAXIMUM NUMBER OF INTEGER FIELD ITEMS ALLOWED IN HACS
C                    DEFAULT FILE.  READ FROM DEFAULT FILE BUT NOT
C                    OTHERWISE USED IN THIS PROGRAM.
```

```
C        MOD    = DATA WORD CONTAINING LABELS USED IN MESSAGE INPUT
C                    PROMPT DISPLAY FOR REAL OR INTEGER FIELDS.
C        MSG    = TEXT LABEL STORED AS PART OF DEFAULT FILE
C        NDEX   = FILE TABLE USED BY MASS STORAGE ROUTINES, DIMENSIONED
C                    TO NUMBER OF TEXT MESSAGES + 1
C        NF     = ACTUAL NUMBER OF REAL DATA FIELDS CONTAINED IN HACS
C                    DEFAULT FILE
C        NFLD   = TOTAL NUMBER OF DATA FIELDS STORED IN HACS DEFAULT
C                    FILE (=NF+NI).  DEFINITIONS OF EACH MESSAGE ARE
C                    STORED SEQUENTIALLY IN ARRAY LIST.
C        NI     = ACTUAL NUMBER OF INTEGER DATA FIELDS CONTAINED IN HACS
C                    DEFAULT FILE
C        NLIN   = LINE COUNTER, USED TO LIMIT MULTIPLE LINE TEXT
C                    MESSAGES TO NOT MORE THAN 9 LINES OF TEXT FOLLOWED
C                    BY SINGLE BLANK LINE AS A DELIMITER.
C        ONE    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 1
C        PACK   = ARRAY CONTAINING PACKED MESSAGE TEXT DATA TO BE
C                    WRITTEN TO MS FILE.
C        TERM   = DATA WORD CONTAINING CHARACTERS TO CLOSE MESSAGE
C                    IN PACK FOR USE AS EXECUTION TIME FORMAT
C        TEXT   = ARRAY USED TO ACCUMULATE MESSAGE LINE INPUT AND
C                    FORMAT CONTROL LINE SEPARATION CHARACTERS IN
C                    SINGLE CHARACTER (A1) FORMAT.  ALL EMBEDDED BLANKS
C                    BETWEEN LINES ARE REMOVED BEFORE PACKING.
C        THR    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 3
C        TTY    = DEVICE NUMBER USED FOR INPUT UNIT WHEN RUNNING IN
C                    INTERACTIVE MODE
C        TWO    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 2
C        UDFLT  = UNIT DEVICE NUMBER FOR EXTERNAL HACS DEFAULT FILE
C        UTXT   = UNIT DEVICE NUMBER FOR EXTERNAL MS MESSAGE TEXT FILE
C        ZER    = DATA WORD CONTAINING TAG USED TO TEST FOR USER
C                    TERMINATION OF INTERACTIVE TERMINAL SESSION.
C
C        AUTHOR - R.G. POTTS
C                 ARTHUR D. LITTLE, INC.
C                 35/318A ACORN PARK
C                 CAMBRIDGE, MASS.  02140
C                 TEL. 617-864-5770,  EXT. 2813
C
C        DATE   - 22 JULY 1980
C
C
      OCOMMON/BASE/MSG(10),MNF,MNI,NF,NI,LIST(275,6),
      1             FVAL(225,3),IVAL(50,3)
       REAL         MSG
       DIMENSION    DEFLT(2489)
       EQUIVALENCE  (DEFLT(1),MSG(1))
C
C
      ODIMENSION    FORM(6),FPCK(71),LINE(130),MOD(2,2),NDEX(257),
      1             PACK(70),TEXT(684)
      OINTEGER      BUFF,FORM,FPCK,ONE,PACK,TERM,TEXT,THR,TTY,TWO,
      1             UDFLT,UTXT,ZER
       EQUIVALENCE  (FPCK(2),PACK(1))
       DATA         (FORM(I),I=1,6)/1H",1H/,1H9,1HX,1H,,1H"/
       DATA         FPCK(1)/10H(9X,      "/,IBLNK/1H /,IBTCH/12/,LP/6/
      ODATA         MOD(1,1)/4HINTE/,MOD(1,2)/3HGER/,MOD(2,1)/4HREAL/,
      1             MOD(2,2)/1H /,ONE/1H1/,TERM/2H")/,THR/1H3/,TTY/5/,
      2             TWO/1H2/,UDFLT/10/,UTXT/11/,ZER/1H0/
C
C
C--------SELECT BATCH OR INTERACTIVE INPUT UNIT
   10 WRITE(TTY,1000)
      IF(EOF(TTY)) 20,20
   20 READ(TTY,1010) ISW
      IF(ISW.EQ.0) GO TO 30
      IF(ISW.NE.1) GO TO 10
      IN=IBTCH
      GO TO 40
   30 IN=TTY
   40 CONTINUE
C
```

```
C--------READ EXTERNAL DEFAULT FILE CONTAINING FIELD NUMBERS AND
C           NAMES INDEXED SEQUENTIALLY.
      REWIND UDFLT
      READ(UDFLT) DEFLT
C
C--------PROGRAM ASSUMES DEFAULT FILE CONTAINS EXACTLY 256 ENTRIES.
      NFLD=NF+NI
      IF(NFLD.EQ.256) GO TO 50
      WRITE(LP,1020)
      STOP
   50 CONTINUE
C
C--------OPEN MASS STORAGE MESSAGE FILE, INDEXED BY MESSAGE NUMBER
      CALL OPENMS(UTXT,NDEX,32,0)
C
C--------READ AND VALIDATE NUMBER OF LAST MESSAGE ENTERED TO INITIALIZE
C           START OF SEQUENCE.
   60 IF(ISW.EQ.0) WRITE(TTY,1030)
      IF(EOF(IN)) 70,70
   70 READ(IN,1040) ISTRT
      IF(ISTRT.LT.0) GO TO 80
      IF(ISTRT.LE.31) GO TO 90
   80 WRITE(LP,1050)
      IF(ISW.EQ.0) GO TO 60
      STOP
   90 CONTINUE
C
C--------START OF EACH NEW CYCLE FOR NEXT MESSAGE.  CLOSE FILE AND STOP
C           AFTER 256 MESSAGES ARE STORED.
  100 ISTRT=ISTRT+1
      IF(ISTRT.LE.31) GO TO 120
  110 CALL CLOSMS(UTXT)
      STOP
  120 CONTINUE
C
C--------READ SINGLE LINE FROM BATCH INPUT FILE (SKIP FOR INTERACTIVE
C           INPUT).  LINE IN FILE GIVES MESSAGE NUMBER, HACS FIELD NUMBER
C           AND HACS FIELD NAME FOR REFERENCE USE.  ONLY THE MESSAGE
C           NUMBER IS READ AND MUST MATCH THE SEQUENCE COUNT ISTRT.
      IF(ISW.EQ.0) GO TO 130
      READ(IN,1040) NMSG
      IF(NMSG.EQ.ISTRT) GO TO 130
      WRITE(LP,1060) NMSG
      STOP
C
C--------WRITE PROMPT DISPLAY FOR EITHER INTERACTIVE OR BATCH INPUT
C           GIVING THE MESSAGE NUMBER, FIELD MODE, NUMBER AND NAME.
  130 IVAR=LIST(ISTRT,2)/1000
      IVAR=IVAR+1
     0WRITE(LP,1070) ISTRT,(MOD(IVAR,I),I=1,2),LIST(ISTRT,1),
     1 (LIST(ISTRT,J),J=3,5)
C
C--------INITIALIZE FOR ACCUMULATION OF MULTIPLE LINE MESSAGES
      M=0
      DO 140 I=1,684
  140 TEXT(I)=IBLNK
      DO 150 I=1,70
  150 PACK(I)=IBLNK
      NLIN=0
C
C--------RETURN HERE TO READ EACH NEW LINE OF MULTIPLE LINE MESSAGE,
C           OR BLANK LINE TERMINATING MESSAGE.  INITIALIZE.
  160 NLIN=NLIN+1
  170 DO 180 I=1,130
  180 LINE(I)=IBLNK
C
C--------READ INPUT LINE OF UP TO 130 CHARACTERS IN A1 FORMAT.  THE
C           FORMAT FOR INTERACTIVE INPUT SUPPRESSES LEADING SPACES.  FOR
C           BATCH INPUT, THE TEXT IS PRECEDED BY FIVE SPACES SINCE THE
C           BATCH FILE CREATED FOR EDITING IS PREPARED BY EXECUTING THE
C           PREVIOUS MESSAGES AS FORMAT STATEMENTS.
      IF(EOF(IN)) 190,190
```

```
  190 CONTINUE
      IF(ISW.EQ.0) READ(IN,1080) LINE
      IF(ISW.EQ.1) READ(IN,1090) LINE
C
C--------LOCATE THE LAST NON-BLANK CHARACTER READ ON THE INPUT LINE.
      DO 200 I=1,130
      J=131-I
      IF(LINE(J).NE.IBLNK) GO TO 210
  200 CONTINUE
      J=0
  210 CONTINUE
C
C--------J GIVES THE INDEX TO THE LAST NON-BLANK CHARACTER READ ON
C         INPUT.  VALID TEXT LINES MAY BE BLANK IF NOT THE FIRST LINE,
C         AND MAY NOT CONTAIN MORE THAN 70 CHARACTERS OF TEXT.
      IF(J.LE.70) GO TO 220
C
C--------SINGLE LINE OVERFLOW.
      WRITE(LP,1100) NLIN
      IF(ISW.EQ.1) STOP
      GO TO 170
C
C--------TEST FOR LAST LINE (BLANK) TERMINATING MESSAGE.
  220 IF(J.GT.0) GO TO 230
C
C--------IF BLANK LINE IS PRECEDED BY TEXT, HAVE VALID END OF MESSAGE.
C         BRANCH TO PROCESS.  OTHERWISE, HAVE ERROR.
      IF(M.GT.0) GO TO 270
      WRITE(LP,1110)
      IF(ISW.EQ.1) STOP
      GO TO 170
C
C--------GET HERE WITH MESSAGE TEXT ENTERED FOR SINGLE LINE.  TEXT
C         MESSAGES ARE ALLOWED FOR UP TO 9 NON-BLANK LINES OF TEXT.  AN
C         ERROR OCCURS IF MORE THAN 9 LINES ARE ENTERED.
  230 IF(NLIN.LE.9) GO TO 240
      WRITE(LP,1120)
      IF(ISW.EQ.1) STOP
      GO TO 130
C
C--------APPEND NEW LINE OF TEXT TO ACCUMULATED MESSAGE TEXT, INSERT
C         OUTPUT FORMAT CONTROL AT END OF EACH NEW LINE, THEN RETURN TO
C         READ NEXT TEXT LINE OR BLANK DELIMITER.
  240 DO 250 I=1,J
      M=M+1
  250 TEXT(M)=LINE(I)
      DO 260 I=1,6
      M=M+1
  260 TEXT(M)=FORM(I)
      GO TO 160
C
C--------BLANK LINE HAS BEEN READ TERMINATING VALID MESSAGE.  REMOVE
C         LAST FORMAT CONTROL IN TEXT.
  270 DO 280 I=1,6
      TEXT(M)=IBLNK
  280 M=M-1
C
C--------CHECK FOR CODES IN MESSAGE TEXT.  0 TERMINATES THE RUN, AND
C         CODES 1 AND 2 PRODUCE BLANK (NULL) MESSAGES.
      IF(TEXT(1).EQ.ZER) GO TO 110
      IF(TEXT(1).EQ.ONE) GO TO 300
      IF(TEXT(1).EQ.TWO) GO TO 300
C
C--------MESSAGE IS EITHER UNCODED, OR CODED AS 3.  IF MESSAGE IS
C         UNCODED, PACK 1 TO M CHARACTERS FROM TEXT INTO WORDS 1 TO J
C         OF ARRAY PACK.  IF MESSAGE IS CODED AS 3, SET PACK(1) TO CODE
C         THEN PACK 2 TO M CHARACTERS FROM TEXT INTO WORDS 2 TO J OF
C         PACK.  MOVE TO AUDIT AND FILE UPDATE WHEN DONE.
      IF(TEXT(1).EQ.THR) GO TO 290
      IO=1
      LEN=M
      J=LEN+9
```

```
      J=J/10
      GO TO 295
  290 IO=2
      LEN=M-1
      J=LEN+9
      J=J/10
      J=J+1
      PACK(1)=TEXT(1)
      IF(M.GT.1) GO TO 295
      WRITE(LP,1110)
      IF(ISW.EQ.1) STOP
      GO TO 130
  295 ENCODE(LEN,1130,PACK(IO)) (TEXT(I),I=IO,M)
C
C--------PACKED MESSAGE LENGTH CANNOT BE LESS THAN MINIMUM RECORD LENGTH
      IF(J.GE.3) GO TO 310
      WRITE(LP,1135)
      IF(ISW.EQ.1) STOP
      GO TO 130
C
C--------PREPARE OUTPUT FOR MESSAGES CODED AS 1 OR 2.  CODE WORD IS
C        FOLLOWED BY TWO BLANK WORDS FOR MINIMUM MESSAGE LENGTH OF 3
C        WORDS.
  300 J=3
      PACK(1)=TEXT(1)
      PACK(2)=IBLNK
      PACK(3)=IBLNK
C
C--------DISPLAY MESSAGE FROM PACKED, CODED FORMAT
  310 IF(PACK(1).EQ.ONE) GO TO 320
      IF(PACK(1).EQ.TWO) GO TO 320
      IF(PACK(1).EQ.THR) GO TO 320
      WRITE(LP,1140)
      JP=J+1
      PACK(JP)=TERM
      WRITE(LP,FPCK)
      GO TO 330
  320 WRITE(LP,1150) PACK(1)
      IF(PACK(1).NE.THR) GO TO 330
      JP=J+1
      PACK(JP)=TERM
      PACK(1)=FPCK(1)
      WRITE(LP,PACK)
      PACK(1)=THR
C
C--------AFTER AUDIT, IN INTERACTIVE MODE, QUERY USER FOR VERIFICATION.
C        ANY NON-BLANK RESPONSE CANCELS MESSAGE.
  330 IF(ISW.EQ.1) GO TO 350
      WRITE(LP,1160)
      BUFF=IBLNK
      IF(EOF(IN)) 340,340
  340 READ(IN,1170) BUFF
      IF(BUFF.NE.IBLNK) GO TO 130
C
C--------WRITE MESSAGE TO OUTPUT FILE, THEN REPEAT ENTIRE PROCESS
C        FOR NEXT MESSAGE, UP TO 256 MESSAGES.
  350 CALL WRITMS(UTXT,PACK,J,ISTRT)
      GO TO 100
C
 1000 FORMAT (//40H  HACS DATA FIELD MESSAGE UPDATE PROGRAM//47H  ENTER
     10 FOR INTERACTIVE OR 1 FOR BATCH INPUT:)
 1010 FORMAT (I1)
 1020 FORMAT (5X,54H*****ERROR - DEFAULT FILE DOES NOT CONTAIN 256 ENTRI
     1ES)
 1030 FORMAT (//50H  ENTER NUMBER OF LAST MESSAGE SAVED IN I3 FORMAT:)
 1040 FORMAT (I3)
 1050 FORMAT (5X,54H*****ERROR - LAST MESSAGE NUMBER NOT IN RANGE 0 TO 2
     156)
 1060 FORMAT (5X,21H*****ERROR - MESSAGE ,I3,33H IS OUT OF SEQUENCE ON I
     1NPUT FILE)
 1070 FORMAT (/5X,34HENTER 0 OR CODED TEXT FOR MESSAGE ,I3,2H, ,A4,A3,
     1 7H FIELD ,I4,2X,3A4,1H:/)
```

```
 1080 FORMAT (130A1)
 1090 FORMAT (9X,130A1)
 11000FORMAT (5X,18H*****ERROR - LINE ,I2,48H EXCEEDS LENGTH OF 70 CHARA
     1CTERS. RE-ENTER LINE.)
 11100FORMAT (5X,68H*****ERROR - MESSAGE NOT FOUND. ENTER TEXT FOLLOWED
     1BY A BLANK LINE.)
 11200FORMAT (5X,73H*****ERROR - MESSAGE EXCEEDS MAXIMUM LENGTH OF 9 LIN
     1ES. RE-ENTER MESSAGE.)
 1130 FORMAT (684A1)
 11350FORMAT (5X,82H*****ERROR - MESSAGE TOO SHORT (MINIMUM LENGTH = 21
     1CHARACTERS). RE-ENTER MESSAGE.)
 1140 FORMAT (5X,24HMESSAGE IS UNCODED TEXT:/)
 1150 FORMAT (5X,25HMESSAGE IS CODED AS TYPE ,A1/)
 1160 FORMAT (4H OK?)
 1170 FORMAT (A10)
      END
READY.
```

7.2.3 Model Text (File MTXLOD)

```
      PROGRAM MTXLOD(OUTPUT,TAPE6=OUTPUT,TAPE11,TAPE12)
C
C        PROGRAM MTXLOD (FOR MESSAGE TEXT LOAD) WAS CREATED BY ADAPTING
C        THE FIELD TEXT LOAD PROGRAM FOR THE FOLLOWING SPECIAL CASE.
C        ONLY BATCH INPUT IS ALLOWED FROM A FILE OF UNCODED MESSAGE
C        TEXT DATA.  EACH MESSAGE IS SEPARATED BY A BLANK LINE, CONTAINS
C        AT LEAST ONE LINE OF TEXT, AND A MAXIMUM OF 25 LINES OF TEXT.
C        EACH LINE IS LIMITED TO NOT MORE THAN 70 CHARACTERS.  THE
C        COMPLETE FILE CONTAINS EXACTLY 29 MESSAGES.  REFER TO LISTING
C        OF PROGRAM TXTLOD FOR DEFINITIONS AND ADDITIONAL INFORMATION.
C
C
     0DIMENSION   FORM(6),FPCK(192),LINE(80),NDEX(30),PACK(191),
     1            TEXT(1900)
      INTEGER     FORM,FPCK,PACK,TERM,TEXT,UTXT
      EQUIVALENCE (FPCK(2),PACK(1))
     0DATA        (FORM(I),I=1,6)/1H',1H/,1H9,1HX,1H,,1H'/,
     1            FPCK(1)/10H(9X,      '/,IBLNK/1H /,IN/11/,LP/6/,
     2            TERM/2H')/,UTXT/12/
C
C
      NMSG=0
      CALL OPENMS(UTXT,NDEX,30,0)
  100 NMSG=NMSG+1
      IF(NMSG.LE.29) GO TO 120
      CALL CLOSMS(UTXT)
      STOP
  120 M=0
      DO 140 I=1,1900
  140 TEXT(I)=IBLNK
      DO 150 I=1,190
  150 PACK(I)=IBLNK
      NLIN=0
  160 NLIN=NLIN+1
      DO 180 I=1,80
  180 LINE(I)=IBLNK
      READ(IN,1090) LINE
      DO 200 I=1,80
      J=81-I
      IF(LINE(J).NE.IBLNK) GO TO 210
  200 CONTINUE
      J=0
  210 CONTINUE
      IF(J.LE.70) GO TO 220
      WRITE(LP,1100) LINE
      STOP
  220 IF(J.GT.0) GO TO 230
      IF(M.GT.0) GO TO 270
      WRITE(LP,1110)
      STOP
  230 IF(NLIN.LE.25) GO TO 240
      WRITE(LP,1120)
      STOP
  240 DO 250 I=1,J
      M=M+1
  250 TEXT(M)=LINE(I)
      DO 260 I=1,6
      M=M+1
  260 TEXT(M)=FORM(I)
      GO TO 160
  270 M=M-6
      ENCODE(M,1130,PACK(1)) (TEXT(I),I=1,M)
      WRITE(LP,1140) NMSG
      J=M+9
      J=J/10
      I=J+1
      PACK(I)=TERM
```

```
      WRITE(LP,FPCK)
      CALL WRITMS(UTXT,PACK,J,NMSG)
      GO TO 100
C
 1090 FORMAT (80A1)
 1100 FORMAT (15H LINE OVERFLOW:,80A1)
 1110 FORMAT (14H BLANK MESSAGE)
 1120 FORMAT (15H TOO MANY LINES)
 1130 FORMAT (1900A1)
 1140 FORMAT (//1X,8HMESSAGE ,I2//)
      END
READY.
```

7.3 Message File Display

Section 7.3 contains listings of the programs used to obtain displays of the message text files created by the programs listed in Section 7.2. Three versions are provided, one for field text, one for scenario text and one for model text.

The original version of the program was written to process coded field text messages and to provide as output a file of message data. The output file can either be printed for display or edited and re-entered into the file build program for updating in batch mode. Complete details are contained in comments in the program listing.

The program used to display scenario messages is nearly, but not quite, identical to that used for field text messages. Displays appropriate for data field items, but not scenarios, were not changed.

The file containing model text data is displayed using a very simplified version of the program, with output directly to the terminal.

Note that the maximum message lengths, number of messages, format control characters, and related message attributes are different among these three programs and the files they process.

7.3.1 Field Text (File RGPMSG)

```
      PROGRAM DISPLAY(OUTPUT,TAPE6=OUTPUT,TAPE10,TAPE11,TAPE12)
C
C        PROGRAM WRITES A DISPLAY OF THE HACS FIELD TEXT MESSAGE
C        FILE (TAPE 11) TO AN OUTPUT FILE (TAPE 12) IN BATCH UPDATE
C        FORMAT.  THE CONTENTS OF THE OUTPUT FILE CAN THEN BE PRINTED
C        USING A SYSTEM UTILITY, OR CAN BE EDITED (ALSO BY A SYSTEM
C        UTILITY).  THE OUTPUT FILE IS FORMATTED SO THAT AFTER EDITING
C        IT CAN BE PROCESSED BY THE MESSAGE UPDATE PROGRAM IN BATCH
C        MODE TO PRODUCE AN UPDATED MESSAGE FILE.  REFER TO THE MESSAGE
C        UPDATE PROGRAM LISTING FOR A DESCRIPTION OF THE MESSAGE CODES
C        AND MESSAGE FILE FORMAT.
C
C        THE HACS DEFAULT FILE IS READ BY THIS PROGRAM TO OBTAIN
C        FIELD NUMBERS, NAMES AND VARIABLE TYPES FOR USE IN DISPLAYS
C        AND TO CORRELATE THE SEQUENTIAL MESSAGE NUMBERS (FROM 1 TO 256)
C        WITH FIELD POSITIONS IN THE DEFAULT FILE.  IF THE MESSAGE FILE
C        IS NOT FULL, THAT IS, CONTAINS LESS THAN 256 MESSAGES, THIS
C        PROGRAM WILL TERMINATE WITH AN MS FILE READ ERROR.
C
C        CODED MESSAGES WRITTEN BY THIS PROGRAM ARE GENERATED BY
C        READING TEXT FROM THE MESSAGE FILE, APPENDING APPROPRIATE
C        FORTRAN FORMAT CODES TO THE MESSAGE STORED AS AN ARRAY, THEN
C        USING THE ARRAY AS AN EXECUTION TIME FORMAT.
C
C
C        DEFLT  = EXTERNAL HACS DEFAULT FILE, READ TO OBTAIN HACS
C                    FIELD NUMBER, FIELD NAME AND FIELD TYPE (INTEGER
C                    OR REAL) CORRESPONDING TO SEQUENTIAL FIELD
C                    MESSAGE NUMBERS.
C        FPCK   = ARRAY EQUIVALENCED TO UNCODED, PACKED MESSAGE TEXT
C                    AND CONTAINING STANDARD FORMAT CODE IN FIRST WORD
C        FVAL   = ARRAY OF DEFAULT VALUES FOR REAL FIELDS, READ FROM
C                    DEFAULT FILE BUT NOT USED IN THIS PROGRAM
C        I      = INDEX ON MESSAGE NUMBER FROM 1 TO NFLD
C        IVAL   = ARRAY OF DEFAULT VALUES FOR INTEGER FIELDS, READ FROM
C                    DEFAULT FILE BUT NOT USED IN THIS PROGRAM
C        IVAR   = CODED FIELD TYPE INDICATOR PACKED IN ARRAY LIST FOR
C                    EACH HACS DATA FIELD (0=INTEGER FIELD, 1=REAL FIELD)
C        J      = GENERAL SUBSCRIPT INDEX
C        LIST   = ARRAY OF CODES IN HACS DEFAULT FILE DEFINING THE
C                    STRUCTURE OF DATA FIELD ITEM I AS LIST(I,J) WHERE
C                    J=1,6.  REFER TO HACS PROGRAM DOCUMENTATION FOR
C                    COMPLETE DETAILS.
C        MNF    = MAXIMUM NUMBER OF REAL FIELD ITEMS ALLOWED IN HACS
C                    DEFAULT FILE
C        MNI    = MAXIMUM NUMBER OF INTEGER FIELD ITEMS ALLOWED IN HACS
C                    DEFAULT FILE
C        MOD    = DATA ARRAY USED TO DISPLAY FIELD TYPE LABELS
C        MSG    = TEXT LABEL STORED AS PART OF DEFAULT FILE
C        NDEX   = FILE TABLE USED BY MASS STORAGE ROUTINES, DIMENSIONED
C                    TO NUMBER OF TEXT MESSAGES + 1
C        NF     = ACTUAL NUMBER OF REAL DATA ITEMS CONTAINED IN HACS
C                    DEFAULT FILE
C        NFLD   = TOTAL NUMBER OF DATA FIELDS STORED IN HACS DEFAULT
C                    FILE (=NF+NI).  DEFINITIONS OF EACH MESSAGE ARE
C                    STORED SEQUENTIALLY IN ARRAY LIST.
C        NI     = ACTUAL NUMBER OF INTEGER DATA ITEMS CONTAINED IN HACS
C                    DEFAULT FILE
C        NW     = LENGTH OF LAST RECORD, IN WORDS, READ FROM
C                    MESSAGE FILE
C        ONE    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 1
C        OUT    = UNIT DEVICE NUMBER FOR OUTPUT FILE CREATED BY THIS
C                    PROGRAM
C        PACK   = ARRAY CONTAINING PACKED MESSAGE TEXT DATA READ FROM
C                    MS FILE, MAXIMUM RECORD LENGTH OF 69.  DIMENSIONED
C                    AS 70 WORD ARRAY TO ALLOW FORMAT CODE TO BE ADDED
C                    AFTER TEXT.
```

```
C         STRT   = SPECIAL FORMAT TAG FOR TYPE 3 MESSAGES, CREATES
C                   DISPLAY IN UPDATE FORMAT WITH CODE 3 IN FIRST
C                   POSITION, FIRST CHARACTER OF MESSAGE TEXT IN
C                   SECOND POSITION
C         TERM   = DATA WORD CONTAINING CHARACTERS TO CLOSE MESSAGE
C                   IN PACK FOR USE AS EXECUTION TIME FORMAT.
C         THR    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 3
C         TWO    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 2
C         UDFLT  = UNIT DEVICE NUMBER FOR EXTERNAL HACS DEFAULT FILE
C         UTXT   = UNIT DEVICE NUMBER FOR EXTERNAL MS MESSAGE TEXT FILE
C
C         AUTHOR - R.G. POTTS
C                  ARTHUR D. LITTLE, INC.
C                  35/318A ACORN PARK
C                  CAMBRIDGE, MASS.  02140
C                  TEL. 617-864-5770,  EXT. 2813
C
C         DATE   - 20 AUGUST 1980
C
C
     0COMMON/BASE/MSG(10),MNF,MNI,NF,NI,LIST(275,6),
     1             FVAL(225,3),IVAL(50,3)
      REAL         MSG
      DIMENSION    DEFLT(2489)
      EQUIVALENCE (DEFLT(1),MSG(1))
C
C
      DIMENSION    FPCK(71),MOD(2,2),NDEX(257),PACK(70)
      INTEGER      FPCK,ONE,OUT,PACK,STRT,TERM,THR,TWO,UDFLT,UTXT
      EQUIVALENCE (FPCK(2),PACK(1))
     0DATA         FPCK(1)/10H(5X,      '/,MOD(1,1)/4HINTE/,
     1             MOD(1,2)/3HGER/,MOD(2,1)/4HREAL/,MOD(2,2)/1H /,
     2             ONE/1H1/,OUT/12/,STRT/10H(5X,     '3/,TERM/2H')/,
     3             THR/1H3/,TWO/1H2/,UDFLT/10/,UTXT/11/
C
C
C--------READ EXTERNAL DEFAULT FILE CONTAINING FIELD NUMBERS AND
C         NAMES INDEXED SEQUENTIALLY.  TOTAL NUMBER OF FIELDS ON FILE
C         IS SUM OF REAL AND INTEGER FIELDS.
      REWIND UDFLT
      READ(UDFLT) DEFLT
      NFLD=NF+NI
C
C--------WRITE INITIAL MESSAGE WITH STARTING MESSAGE NUMBER FOR
C         USE IN BATCH UPDATE
      WRITE(OUT,1000)
C
C--------OPEN MASS STORAGE MESSAGE FILE, INDEXED BY MESSAGE NUMBER,
C         AND START LOOP ON MESSAGES FROM 1 TO NFLD
      CALL OPENMS(UTXT,NDEX,257,0)
      DO 40 I=1,NFLD
C
C--------DISPLAY MESSAGE NUMBER TOGETHER WITH HACS FIELD MODE, NUMBER
C         AND NAME.
      IVAR=LIST(I,2)/1000
      IVAR=IVAR+1
      WRITE(OUT,1010) I,(MOD(IVAR,J),J=1,2),LIST(I,1),(LIST(I,J),J=3,5)
C
C--------READ AND DECODE MESSAGE I
      CALL READMS(UTXT,PACK,69,I)
      NW=LENGTH(UTXT)
      IF(PACK(1).EQ.ONE) GO TO 10
      IF(PACK(1).EQ.TWO) GO TO 10
      NW=NW+1
      PACK(NW)=TERM
      IF(PACK(1).EQ.THR) GO TO 20
C
C--------OUTPUT UNCODED MESSAGE
      WRITE(OUT,FPCK)
      GO TO 30
C
C--------WRITE CODED MESSAGES, TYPES 1 AND 2
```

```
   10 WRITE(OUT,1020) PACK(1)
      GO TO 30
C
C--------WRITE CODED MESSAGE, TYPE 3, IN UPDATE FORMAT
   20 PACK(1)=STRT
      WRITE(OUT,PACK)
C
C--------WRITE MESSAGE DELIMITER, THEN CONTINUE LOOP FOR ALL MESSAGES.
   30 WRITE(OUT,1030)
   40 CONTINUE
      STOP
C
 1000 FORMAT (42H000 = NUMBER OF LAST MESSAGE ON PRIOR FILE)
 10100FORMAT (I3,21H = MESSAGE INDEX FOR ,A4,A3,7H FIELD ,I4,2X,3A4,
     1 15H, MESSAGE TEXT:)
 1020 FORMAT (5X,A1)
 1030 FORMAT (5X)
      END
READY.
```

7.3.2 Scenario Text (File RPSMSG)

```
      PROGRAM DISPLAY(OUTPUT,TAPE6=OUTPUT,TAPE10,TAPE11,TAPE12)
C
C        PROGRAM WRITES A DISPLAY OF THE HACS FIELD TEXT MESSAGE
C        FILE (TAPE 11) TO AN OUTPUT FILE (TAPE 12) IN BATCH UPDATE
C        FORMAT.  THE CONTENTS OF THE OUTPUT FILE CAN THEN BE PRINTED
C        USING A SYSTEM UTILITY, OR CAN BE EDITED (ALSO BY A SYSTEM
C        UTILITY).  THE OUTPUT FILE IS FORMATTED SO THAT AFTER EDITING
C        IT CAN BE PROCESSED BY THE MESSAGE UPDATE PROGRAM IN BATCH
C        MODE TO PRODUCE AN UPDATED MESSAGE FILE.  REFER TO THE MESSAGE
C        UPDATE PROGRAM LISTING FOR A DESCRIPTION OF THE MESSAGE CODES
C        AND MESSAGE FILE FORMAT.
C
C        THE HACS DEFAULT FILE IS READ BY THIS PROGRAM TO OBTAIN
C        FIELD NUMBERS, NAMES AND VARIABLE TYPES FOR USE IN DISPLAYS
C        AND TO CORRELATE THE SEQUENTIAL MESSAGE NUMBERS (FROM 1 TO 256)
C        WITH FIELD POSITIONS IN THE DEFAULT FILE.  IF THE MESSAGE FILE
C        IS NOT FULL, THAT IS, CONTAINS LESS THAN 256 MESSAGES, THIS
C        PROGRAM WILL TERMINATE WITH AN MS FILE READ ERROR.
C
C        CODED MESSAGES WRITTEN BY THIS PROGRAM ARE GENERATED BY
C        READING TEXT FROM THE MESSAGE FILE, APPENDING APPROPRIATE
C        FORTRAN FORMAT CODES TO THE MESSAGE STORED AS AN ARRAY, THEN
C        USING THE ARRAY AS AN EXECUTION TIME FORMAT.
C
C
C        DEFLT  = EXTERNAL HACS DEFAULT FILE, READ TO OBTAIN HACS
C                     FIELD NUMBER, FIELD NAME AND FIELD TYPE (INTEGER
C                     OR REAL) CORRESPONDING TO SEQUENTIAL FIELD
C                     MESSAGE NUMBERS.
C        FPCK   = ARRAY EQUIVALENCED TO UNCODED, PACKED MESSAGE TEXT
C                     AND CONTAINING STANDARD FORMAT CODE IN FIRST WORD
C        FVAL   = ARRAY OF DEFAULT VALUES FOR REAL FIELDS, READ FROM
C                     DEFAULT FILE BUT NOT USED IN THIS PROGRAM
C        I      = INDEX ON MESSAGE NUMBER FROM 1 TO NFLD
C        IVAL   = ARRAY OF DEFAULT VALUES FOR INTEGER FIELDS, READ FROM
C                     DEFAULT FILE BUT NOT USED IN THIS PROGRAM
C        IVAR   = CODED FIELD TYPE INDICATOR PACKED IN ARRAY LIST FOR
C                     EACH HACS DATA FIELD (0=INTEGER FIELD, 1=REAL FIELD)
C        J      = GENERAL SUBSCRIPT INDEX
C        LIST   = ARRAY OF CODES IN HACS DEFAULT FILE DEFINING THE
C                     STRUCTURE OF DATA FIELD ITEM I AS LIST(I,J) WHERE
C                     J=1,6.  REFER TO HACS PROGRAM DOCUMENTATION FOR
C                     COMPLETE DETAILS.
C        MNF    = MAXIMUM NUMBER OF REAL FIELD ITEMS ALLOWED IN HACS
C                     DEFAULT FILE
C        MNI    = MAXIMUM NUMBER OF INTEGER FIELD ITEMS ALLOWED IN HACS
C                     DEFAULT FILE
C        MOD    = DATA ARRAY USED TO DISPLAY FIELD TYPE LABELS
C        MSG    = TEXT LABEL STORED AS PART OF DEFAULT FILE
C        NDEX   = FILE TABLE USED BY MASS STORAGE ROUTINES, DIMENSIONED
C                     TO NUMBER OF TEXT MESSAGES + 1
C        NF     = ACTUAL NUMBER OF REAL DATA ITEMS CONTAINED IN HACS
C                     DEFAULT FILE
C        NFLD   = TOTAL NUMBER OF DATA FIELDS STORED IN HACS DEFAULT
C                     FILE (=NF+NI).  DEFINITIONS OF EACH MESSAGE ARE
C                     STORED SEQUENTIALLY IN ARRAY LIST.
C        NI     = ACTUAL NUMBER OF INTEGER DATA ITEMS CONTAINED IN HACS
C                     DEFAULT FILE
C        NW     = LENGTH OF LAST RECORD, IN WORDS, READ FROM
C                     MESSAGE FILE
C        ONE    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 1
C        OUT    = UNIT DEVICE NUMBER FOR OUTPUT FILE CREATED BY THIS
C                     PROGRAM
C        PACK   = ARRAY CONTAINING PACKED MESSAGE TEXT DATA READ FROM
C                     MS FILE, MAXIMUM RECORD LENGTH OF 69.  DIMENSIONED
C                     AS 70 WORD ARRAY TO ALLOW FORMAT CODE TO BE ADDED
C                     AFTER TEXT.
```

```
C        STRT   = SPECIAL FORMAT TAG FOR TYPE 3 MESSAGES, CREATES
C                  DISPLAY IN UPDATE FORMAT WITH CODE 3 IN FIRST
C                  POSITION, FIRST CHARACTER OF MESSAGE TEXT IN
C                  SECOND POSITION
C        TERM   = DATA WORD CONTAINING CHARACTERS TO CLOSE MESSAGE
C                  IN PACK FOR USE AS EXECUTION TIME FORMAT.
C        THR    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 3
C        TWO    = DATA WORD CONTAINING TAG FOR CODED MESSAGES, TYPE 2
C        UDFLT  = UNIT DEVICE NUMBER FOR EXTERNAL HACS DEFAULT FILE
C        UTXT   = UNIT DEVICE NUMBER FOR EXTERNAL MS MESSAGE TEXT FILE
C
C        AUTHOR - R.G. POTTS
C                 ARTHUR D. LITTLE, INC.
C                 35/318A ACORN PARK
C                 CAMBRIDGE, MASS.  02140
C                 TEL. 617-864-5770,  EXT. 2813
C
C        DATE   - 20 AUGUST 1980
C
C
     0COMMON/BASE/MSG(10),MNF,MNI,NF,NI,LIST(275,6),
     1             FVAL(225,3),IVAL(50,3)
      REAL         MSG
      DIMENSION    DEFLT(2489)
      EQUIVALENCE (DEFLT(1),MSG(1))
C
C
      DIMENSION    FPCK(71),MOD(2,2),NDEX(257),PACK(70)
      INTEGER      FPCK,ONE,OUT,PACK,STRT,TERM,THR,TWO,UDFLT,UTXT
      EQUIVALENCE (FPCK(2),PACK(1))
     0DATA         FPCK(1)/10H(9X,      '/,MOD(1,1)/4HINTE/,
     1             MOD(1,2)/3HGER/,MOD(2,1)/4HREAL/,MOD(2,2)/1H /,
     2             ONE/1H1/,OUT/12/,STRT/10H(5X,     '3/,TERM/2H')/,
     3             THR/1H3/,TWO/1H2/,UDFLT/10/,UTXT/11/
C
C
C--------READ EXTERNAL DEFAULT FILE CONTAINING FIELD NUMBERS AND
C        NAMES INDEXED SEQUENTIALLY.  TOTAL NUMBER OF FIELDS ON FILE
C        IS SUM OF REAL AND INTEGER FIELDS.
      REWIND UDFLT
      READ(UDFLT) DEFLT
      NFLD=NF+NI
C
C--------WRITE INITIAL MESSAGE WITH STARTING MESSAGE NUMBER FOR
C        USE IN BATCH UPDATE
      WRITE(OUT,1000)
C
C--------OPEN MASS STORAGE MESSAGE FILE, INDEXED BY MESSAGE NUMBER,
C        AND START LOOP ON MESSAGES FROM 1 TO NFLD
      CALL OPENMS(UTXT,NDEX,31,0)
      DO 40 I=1,NFLD
C
C--------DISPLAY MESSAGE NUMBER TOGETHER WITH HACS FIELD MODE, NUMBER
C        AND NAME.
      IVAR=LIST(I,2)/1000
      IVAR=IVAR+1
      WRITE(OUT,1010) I,(MOD(IVAR,J),J=1,2),LIST(I,1),(LIST(I,J),J=3,5)
C
C--------READ AND DECODE MESSAGE I
      CALL READMS(UTXT,PACK,69,I)
      NW=LENGTH(UTXT)
      IF(PACK(1).EQ.ONE) GO TO 10
      IF(PACK(1).EQ.TWO) GO TO 10
      NW=NW+1
      PACK(NW)=TERM
      IF(PACK(1).EQ.THR) GO TO 20
C
C--------OUTPUT UNCODED MESSAGE
      WRITE(OUT,FPCK)
      GO TO 30
C
C--------WRITE CODED MESSAGES, TYPES 1 AND 2
```

```
   10 WRITE(OUT,1020) PACK(1)
      GO TO 30
C
C--------WRITE CODED MESSAGE, TYPE 3, IN UPDATE FORMAT
   20 PACK(1)=STRT
      WRITE(OUT,PACK)
C
C--------WRITE MESSAGE DELIMITER, THEN CONTINUE LOOP FOR ALL MESSAGES.
   30 WRITE(OUT,1030)
   40 CONTINUE
      STOP
C
 1000 FORMAT (42H000 = NUMBER OF LAST MESSAGE ON PRIOR FILE)
 10100FORMAT (I3,21H = MESSAGE INDEX FOR ,A4,A3,7H FIELD ,I4,2X,3A4,
     1 15H, MESSAGE TEXT:)
 1020 FORMAT (5X,A1)
 1030 FORMAT (5X)
      END
READY.
```

7.3.3 Model Text (File RGPEDT)

```
      PROGRAM DISPLAY(OUTPUT,TAPE6=OUTPUT,TAPE12)
      DIMENSION FPCK(192),NDEX(30),PACK(191)
      INTEGER FPCK,PACK,TERM,UTXT
      EQUIVALENCE (FPCK(2),PACK(1))
      DATA FPCK(1)/10H(9X,      '/,UTXT/12/,LP/6/,TERM/2H')/
      CALL OPENMS(UTXT,NDEX,30,0)
      DO 40 I=1,29
      CALL READMS(UTXT,PACK,190,I)
      NW=LENGTH(UTXT)
      NW=NW+1
      PACK(NW)=TERM
      WRITE(LP,1000) I
 1000 FORMAT (//1X,'MESSAGE ',I2//)
      WRITE(LP,FPCK)
   40 CONTINUE
      STOP
      END
READY.
```

7.4 Utilities

Listings of two utility programs used for different purposes in the HACS/UIM development are given in Sections 7.4.1 and 7.4.2.

Section 7.4.1 contains descriptions and listings of 21 different subroutines that together form a data compression utility package. The routines are used to pack (set) or unpack (read) numeric code values utilizing individual bits within memory words with a set of Fortran callable subroutines. Some of these routines have been incorporated within HACS/UIM. The complete package of code manipulation routines is very general, and should be readily adaptable to other applications requiring data compression.

Three levels of coding capability are provided:

(1) Storing a string of single bit codes within a single memory word,

(2) Storing a string of single bit codes within an array of memory words, and,

(3) Storing a string of multiple bit codes within an array of memory words.

Within each level, the same functional procedures are provided for initialization, set, reset, test, pack and unpack operations. The set, reset and test features operate randomly on code N within a collection of coded values 1 to M. The pack and unpack features operate sequentially on all coded values, 1 to M, providing for bulk transfer of coded information. Detailed documentation of this utility package is given in Section 7.4.1.

In Section 7.4.2, a listing is given of a short utility program that was written to translate tab key entries (ASCII code) to corresponding control of stored file data (BCD code). Source files entered with an ASCII terminal contains lines of text in which the tab character may appear. In BCD mode, the ASCII tab is treated as any other character, and the source data line is unaffected. The version of the program given in Section 7.4.2 was used to process files containing Fortran source code with tab control entered to start comment line text in column 10, and source statement text in column 7.

The program reads each line of the input file, tests for the appearance of tab characters, and inserts spaces in the text as indicated. Both the input and output files are on disk; the output disk file can be listed after the program run to verify the desired tab spacing. Note that this program can readily be modified or adapted for processing similar data input formats to simplify keying operations.

7.4.1 Data Compression (File SAVCOD)

```
C        ****************************************************************
C        *                                                              *
C        *               DATA COMPRESSION UTILITY PACKAGE               *
C        *                                                              *
C        ****************************************************************
C
C
C        THE DATA COMPRESSION UTILITY PACKAGE IS COMPRISED OF A SERIES
C        OF SUBROUTINES AND FUNCTIONS USED TO PACK OR UNPACK NUMERIC
C        CODE VALUES UTILIZING INDIVIDUAL BITS WITHIN MEMORY WORDS.
C        THREE LEVELS OF CAPABILITY ARE PROVIDED -
C
C              (1) STORING A STRING OF SINGLF BIT CODES WITHIN A
C                  SINGLE MEMORY WORD,
C              (2) STORING A STRING OF SINGLE BIT CODES WITHIN AN
C                  ARRAY OF MEMORY WORDS, AND,
C              (3) STORING A STRING OF MULTIPLE BIT CODES WITHIN AN
C                  ARRAY OF MEMORY WORDS.
C
C        WITHIN EACH LEVEL, THE SAME FUNCTIONAL PROCEDURES ARE PROVIDED
C        FOR INITIALIZATION, SET, RESET, TEST, PACK AND UNPACK CODES.
C        THE SET, RESET AND TEST FEATURES OPERATE RANDOMLY ON CODE N
C        WITHIN A COLLECTION OF CODED VALUES 1 TO M.  THE PACK AND
C        UNPACK FEATURES OPERATE SEQUENTIALLY ON ALL CODED VALUES, 1 TO
C        M, PROVIDING FOR BULK TRANSFER OF CODED INFORMATION.
C
C        AUTHOR - R.G. POTTS, ARTHUR D. LITTLE, INC.,
C                             35/318A ACORN PARK,
C                             CAMBRIDGE, MASS., 02140
C                             TEL. 617-864-5770  EXT. 2813
C        DATE   - 17 NOVEMBER 1980
C
C
C        LEVEL (3) ROUTINES =
C
C               SUBROUTINE INIT(CODE,I,J,K)
C               LOGICAL FUNCTION ECHK(N)
C               SUBROUTINE SET(CODE,N,IVAL)
C               SUBROUTINE RSET(CODE,N)
C               FUNCTION ITST(CODE,N)
C               SUBROUTINE PACK(IAR,CODE)
C               SUBROUTINE UNPK(CODE,IAR)
C
C        LEVEL (2) ROUTINES =
C
C               SUBROUTINE INITM(CODE,I,J)
C               LOGICAL FUNCTION ECHKM(N)
C               SUBROUTINE SETM(CODE,N)
C               SUBROUTINE RSETM(CODE,N)
C               FUNCTION ITSTM(CODE,N)
C               SUBROUTINE PACKM(IAR,CODE)
C               SUBROUTINE UNPKM(CODE,IAR)
C
C        LEVEL (1) ROUTINES =
C
C               SUBROUTINE INIT1(CODE,I)
C               LOGICAL FUNCTION ECHK1(N)
C               SUBROUTINE SET1(CODE,N)
C               SUBROUTINE RSET1(CODE,N)
C               FUNCTION ITST1(CODE,N)
C               SUBROUTINE PACK1(IAR,CODE)
C               SUBROUTINE UNPK1(CODE,IAR)
C
C        FUNCTIONS ECHK, ECHKM AND ECHK1 ARE ONLY CALLED BY OTHER BIT
C        MANIPULATION ROUTINES AND ARE NOT USED IN THE CALLING PROGRAM.
C        REMAINING ROUTINES ARE USER CALLABLE AND ARGUMENT DEFINITIONS
C        ARE GIVEN BELOW -
```

```
C
C         CODE    = SINGLE WORD (LEVEL 1) OR INTEGER ARRAY (LEVELS 2 AND
C                     3) FOR STORAGE OF PACKED CODED VALUES AT CPW
C                     CODED VALUES PER WORD.  LEVELS 1 AND 2 USE SINGLE
C                     BIT CODED VALUES (0 OR 1).  LEVEL 3 ROUTINES ASSUME
C                     MULTIPLE BIT CODED VALUES WITHIN A FIXED BYTE SIZE
C                     OF CDLN.
C         I       = INPUT TO INITIALIZATION ROUTINE SPECIFYING THE
C                     MAXIMUM NUMBER OF BITS IN EACH WORD OF CODE WHICH
C                     CAN BE USED FOR STORAGE OF CODED VALUES.
C         IAR     = INTEGER ARRAY CONTAINING UNPACKED CODED VALUES
C                     TO BE MOVED TO CODE (PACK OPERATION) OR TO BE
C                     RECEIVED FROM CODE (UNPACK OPERATION) IN SEQUENTIAL
C                     DATA TRANSFER.
C         IVAL    = NUMERIC EQUIVALENT OF CODE VALUE TO BE PACKED IN
C                     CODE POSITION N BY SUBROUTINE SET.
C         J       = MAXIMUM NUMBER OF WORDS IN ARRAY CODE WHICH ARE
C                     USED FOR STORAGE OF CODED VALUES.  BY DEFINITION,
C                     THIS ARGUMENT APPLIES ONLY TO LEVEL 2 AND 3 ROUTINES
C                     AND A VALUE OF 1 IS USED FOR THE LEVEL 1 ROUTINES.
C         K       = DEFINES THE STORAGE REQUIRED FOR A SINGLE CODED
C                     VALUE FOR LEVEL 3 ROUTINES AT K BITS PER CODE,
C                     K BEING THE LARGEST BYTE REQUIRED TO CONTAIN THE
C                     LARGEST CODED VALUE.  THIS DETERMINES THE ALLOWED
C                     INTEGER MAGNITUDE OF EACH CODED VALUE TO BE GREATER
C                     THAN OR EQUAL TO ZERO, AND LESS THAN 2**K.  LEVEL
C                     1 AND 2 ROUTINES USE SINGLE BIT CODING SO A VALUE
C                     OF 1 IS ASSUMED FOR K.
C         N       = CODED VALUE INDEX NUMBER, VARIES FROM 1 TO MAXIMUM
C                     NUMBER OF CODED VALUES IMPLIED BY I,J,K.
C
C         THE ARRAY IAR AND THE ARRAY CODE (EXCEPT FOR LEVEL 1) MUST BE
C         DIMENSIONED IN THE CALLING PROGRAM ACCORDING TO THE LENGTHS
C         IMPLIED BY I, J AND K.
C
C         THE INITIALIZATION ROUTINES (INIT, INITM AND INIT1) SPECIFY
C         THE CHARACTERISTICS OF THE COMPRESSED DATA STORAGE.  THE
C         APPROPRIATE INITIALIZATION ROUTINE MUST BE CALLED ONCE BEFORE
C         ANY REFERENCE TO A CODED VALUE BY ANY OF THE SET, RESET OR
C         TEST ROUTINES, AND AGAIN ON RE-DEFINITION OF THE CODE WORD
C         OR ARRAY OR ITS STORAGE CHARACTERISTICS.  THE INITIALIZATION
C         ROUTINES MUST ALSO BE CALLED IMMEDIATELY BEFORE EACH CALL TO
C         ONE OF THE PACK OR UNPACK ROUTINES (REFER TO LISTINGS OF SUB-
C         ROUTINES PACK AND UNPK FOR ADDITIONAL INFORMATION).  THE
C         INITIALIZATION PRE-SETS VALUES IN LABELLED COMMON WHICH ARE
C         USED BY THE OTHER MANIPULATION ROUTINES.  DEFINITIONS OF ALL
C         VARIABLES IN COMMON USED BY THESE ROUTINES FOLLOW -
C
C         CDLN    = INTEGER VALUE GIVING LENGTH OF SINGLE CODED VALUE
C                     IN BITS, DETERMINED FROM VALUE OF K (SEE ABOVE)
C         CPW     = MAXIMUM NUMBER OF CODED VALUES WHICH CAN BE STORED
C                     IN A SINGLE WORD (CODE)
C         IERR    = INTEGER ERROR FLAG RETURNED IN COMMON AS ZERO FOR
C                     NO ERROR, OR A VALUE IN THE RANGE 1 TO 9.  IF MORE
C                     THAN ONE ERROR CAN OCCUR, ONLY THE LAST VALUE IS
C                     INDICATED.  SPECIFIC ERROR CODES ARE DEFINED BELOW.
C         ITMP    = INTEGER WORD LOCATION USED AS SCRATCH SPACE FOR
C                     MANIPULATION ROUTINES.
C         L       = INDEX TO WORD OF ARRAY CODE CONTAINING CODED VALUE N
C                     (ASSUMED TO BE 1 FOR LEVEL 1 USE).
C         MAXN    = MAXIMUM NUMBER OF CODED VALUES AS DETERMINED DURING
C                     INITIALIZATION (REPLACED BY CPW IN LEVEL 1)
C         MAXV    = MAXIMUM VALUE OF A SINGLE CODE VALUE FOR LEVEL 3
C                     (=1 FOR LEVELS 1 AND 2).
C         SHFT    = INTEGER FACTOR USED FOR POSITIONING SINGLE CODE VALUE
C                     RELATIVE TO PACKED CODE WORD.
C
C         COMMON VARIABLES ARE STORED IN THE LABELLED COMMON BLOCK
C         NAMED GCODE, AND DIFFERENT LENGTHS ARE DEFINED FOR EACH GROUP
C         OF MANIPULATION ROUTINES (ONLY REQUIRED VARIABLES ARE LISTED).
C         HOWEVER ALL DEFINITIONS OF /GCODE/ ARE COMPATIBLE.  FOR USER
C         TESTING OF ERROR CONDITIONS, THE COMMON AREA MUST ALSO BE
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C       DEFINED IN THE CALLING PROGRAM USING COMMON/GCODE/IERR WHERE
C       IERR MAY BE ANY INTEGER VARIABLE.  AFTER CALLING A MANIPULATION
C       ROUTINE, A VALUE OF ZERO INDICATES NO ERROR, AND A NON-ZERO
C       VALUE INDICATES ONE OR MORE ERRORS OCCURRED.  LEVEL 1 ROUTINES
C       RETURN ERROR CODES 1-6, LEVEL 2 RETURNS 1-7 AND LEVEL 3 RETURNS
C       1-9.  DEFINITIONS OF ALL ERROR CODES FOLLOW -
C
C       0      = NO ERROR CONDITION DETECTED.
C       1      = LENGTH OF WORD IN BITS FOR CODE STORAGE IS ZERO OR
C                   NEGATIVE
C       2      = LENGTH OF WORD IN BITS REQUESTED FOR CODE STORAGE
C                   EXCEEDS MAXIMUM WORD LENGTH SET IN SUBROUTINES
C                   INIT, INITM AND INIT1 AS INSTALLATION PARAMETER.
C       3      = REQUESTED CODE POSITION N HAS A VALUE OF ZERO OR
C                   IS NEGATIVE.
C       4      = REQUESTED CODE POSITION N EXCEEDS THE NUMBER OF
C                   POSITIONS DEFINED FOR COMPACTED STORAGE.
C       5      = CODE VALUE REQUESTED TO BE STORED IS NEGATIVE (MUST
C                   BE ZERO OR POSITIVE).  ZERO IS STORED.
C       6      = CODE VALUE REQUESTED TO BE STORED IS GREATER THAN
C                   MAXIMUM VALUE WHICH CAN BE STORED WITHIN LENGTH
C                   OF CODE SPECIFIED.  MAXIMUM VALUE IS STORED.
C       7      = NUMBER OF WORDS REQUESTED FOR LENGTH OF ARRAY CODE
C                   IS NOT GREATER THAN ZERO.
C       8      = NUMBER OF BITS SPECIFIED FOR LENGTH OF SINGLE CODE
C                   VALUE IS NOT GREATER THAN ZERO.
C       9      = NUMBER OF BITS SPECIFIED FOR LENGTH OF SINGLE CODE
C                   VALUE EXCEEDS SPECIFIED LENGTH OF CODE WORD.
C
C
C       PROGRAM LISTINGS OF ALL SUBROUTINES AND FUNCTIONS FOLLOW.
C       IN GENERAL, LEVEL 3 ROUTINES MAY BE USED TO PERFORM ALL
C       OPERATIONS, HOWEVER FOR APPROPRIATE CODING STRUCTURES, LEVEL
C       2 AND 1 ROUTINES OFFER SIMPLIFIED EXECUTION FOR SIMPLIFIED
C       CODING.  ADDITIONAL NOTES ON USE ARE GIVEN IN INDIVIDUAL
C       PROGRAM LISTINGS.
C
C
C       ***************************************************************
C       *                                                             *
C       *                 LEVEL 1 PROGRAM LISTINGS                    *
C       *                                                             *
C       ***************************************************************
C
C
      SUBROUTINE INIT(CODE,I,J,K)
C
C       SUBROUTINE INIT INITIALIZES THE CODING ROUTINES TO STORE NEW
C       CODES, OR TO READ PREVIOUSLY STORED CODES, IN THE INTEGER
C       ARRAY CODE.  THE ARRAY CODE, MUST BE DIMENSIONED IN THE
C       CALLING PROGRAM TO BE OF LENGTH J OR GREATER.  THE CHARACTER-
C       ISTICS OF THE STORED NUMERIC CODES ARE SPECIFIED BY THE
C       REMAINING ARGUMENTS -
C
C       I      = MAXIMUM NUMBER OF BITS IN EACH WORD OF THE ARRAY CODE
C                   WHICH CAN BE USED FOR STORAGE OF CODED VALUES.
C       J      = MAXIMUM NUMBER OF WORDS IN ARRAY CODE WHICH ARE
C                   USED FOR STORAGE OF CODED VALUES.
C       K      = DEFINES THE STORAGE REQUIRED FOR A SINGLE CODED VALUE
C                   TO BE FIXED LENGTH AT K BITS PER CODE.  THIS DETER-
C                   MINES THE ALLOWED INTEGER MAGNITUDE OF EACH CODED
C                   VALUE TO BE GREATER THAN OR EQUAL TO ZERO, AND LESS
C                   THAN 2**K.
C
C       ON RETURN, THE ERROR FLAG IERR IN COMMON IS ZERO IF NO ERRORS
C       WERE ENCOUNTERED.  ERROR CONDITIONS WILL CAUSE IERR TO BE SET
C       TO 1,2,7,8 OR 9 ON RETURN, AND CONTROL VARIABLES IN COMMON
C       TO BE SET FOR SINGLE BIT, SINGLE WORD CODE STORAGE.
C
C       SUBROUTINE INIT CONTAINS A SINGLE INTERNAL PARAMETER, MXWRD,
C       WHICH DEFINES THE MAXIMUM ALLOWED UNSIGNED INTEGER WORD
C       LENGTH IN BITS AND IS INSTALLATION DEPENDENT.  FOR A NORMAL
```

```
C         16-BIT WORD LENGTH, MXWRD SHOULD BE SET TO 15.  FOR USE WITH
C         DOUBLE PRECISION (TWO-WORD) INTEGERS, MXWRD CAN BE SET TO 31
C         FOR A 16-BIT WORD LENGTH IF INTEGER SPECIFICATIONS ARE ALSO
C         MODIFIED IN THESE ROUTINES.  FOR USE ON THE CDC CYBERNET NET-
C         WORK, INTEGER ARITHMETIC IS LIMITED TO PARTIAL WORDS, SO MXWRD
C         IS SET TO 47 OUT OF 60 BITS AVAILABLE IN THE FULL WORD.
C
C         SUBROUTINE INIT MUST BE CALLED ONCE AND ONLY ONCE FOR EACH
C         CODED ARRAY PRIOR TO ALL CALLS USING THE ROUTINES SET, RSET
C         OR ITST WITH THE CODED ARRAY.  NOTE THAT INIT WILL CLEAR THE
C         CONTENTS OF THE REFERENCED CODED ARRAY.  INIT MUST BE CALLED
C         IMMEDIATELY BEFORE EACH CALL TO THE BULK TRANSFER ROUTINES
C         PACK AND UNPK.
C
C         COMMON VARIABLES USED - CDLN,CPW,IERR,L,MAXN,MAXV
C
C         SUBROUTINES REQUIRED  - NONE
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER       CPW,CDLN,SHFT
C
      INTEGER       CODE(1)
      DATA          MXWRD/47/
C
C
C--------TEST LENGTH OF WORD TO BE USED FOR CODE STORAGE.  CANNOT BE
C         LESS THAN 1 OR EXCEED MAXIMUM UNSIGNED INTEGER WORD LENGTH.
      IF(I.LE.0) GO TO 20
      IF(I.GT.MXWRD) GO TO 30
C
C--------TEST NUMBER OF WORDS TO BE USED FOR CODE STORAGE.  CANNOT BE
C         LESS THAN 1.  UPPER LIMIT IS NOT TESTED SINCE THIS IS
C         CONTROLLED BY USER DIMENSION IN CALLING PROGRAM.
      IF(J.LE.0) GO TO 40
C
C--------TEST NUMBER OF BITS TO BE USED FOR SINGLE CODE.  CANNOT BE
C         LESS THAN 1 OR EXCEED SPECIFIED LENGTH OF CODE WORD.
      IF(K.LE.0) GO TO 50
      IF(K.GT.I) GO TO 60
C
C--------NORMAL RETURN.  COMPUTE NUMBER OF CODES TO BE STORED PER
C         WORD (CPW), INITIALIZE ALL CODE WORDS TO ZERO, AND SET NORMAL
C         ERROR RETURN.  COMPUTE TOTAL NUMBER OF CODES WHICH CAN BE
C         STORED (MAXN), MOVE CODE LENGTH K TO COMMON VARIABLE CDLN,
C         AND COMPUTE MAXIMUM ALLOWED CODE VALUE (MAXV).
      IERR=0
      CPW=I/K
      DO 10 L=1,J
   10 CODE(L)=0
      MAXN=CPW*J
      CDLN=K
      MAXV=2**CDLN-1
      RETURN
C
C--------ERROR RETURNS.  SET VALUE OF ERROR SWITCH IN COMMON AND
C         DEFAULT TO CODE DEFINITION USING SINGLE WORD CONTAINING CODES
C         ONE BIT IN LENGTH.
   20 IERR=1
      GO TO 70
   30 IERR=2
      GO TO 70
   40 IERR=7
      GO TO 70
   50 IERR=8
      GO TO 70
   60 IERR=9
   70 CPW=MXWRD
      CODE(1)=0
      MAXN=MXWRD
      CDLN=1
      MAXV=1
```

```
      RETURN
      END
      LOGICAL FUNCTION ECHK(N)
C
C        LOGICAL FUNCTION ECHK (FOR ERROR CHECK) TESTS THE REQUESTED
C        CODE POSITION SPECIFIED BY THE ARGUMENT N.  IF THE POSITION
C        IS NOT WITHIN THE ALLOWED NUMBER OF CODED VALUES (1 TO MAXN),
C        THE ERROR INDICATOR IERR IN COMMON IS SET TO 3 OR 4 AND THE
C        FUNCTION RETURNS A VALUE OF .TRUE.  ALL OTHER VARIABLES IN
C        COMMON ARE UNCHANGED.
C
C        IF THE SPECIFIED CODE POSITION, N, IS VALID, THE ERROR CHECK
C        FUNCTION RETURNS A VALUE OF .FALSE. AND SETS VARIABLES IN
C        COMMON TO ACCESS THE VALUE OF THE NTH CODE PACKED IN AN ARRAY.
C        GIVEN N, THE LOCATION OF THE CODED VALUE IS DETERMINED BY THE
C        NUMBER OF CODED VALUES PER STORAGE WORD (CPW) AND THE LENGTH
C        OF EACH CODE (CDLN).  BOTH CPW AND CDLN ARE DETERMINED ON
C        INITIALIZATION IN SUBROUTINE INIT.  FOR ACCESSING THE REQUESTED
C        CODE THE FUNCTION RETURNS L AND SHFT.  THE VALUE OF L IS THE
C        SUBSCRIPT INDEX TO THE WORD OF THE PACKED ARRAY CONTAINING
C        THE POSITION FOR THE CODED VALUE.  SHFT IS AN INTEGER MULTI-
C        PLIER OR DIVISOR WHICH WILL MOVE A CODED VALUE OF LENGTH CDLN
C        TO OR FROM ITS POSITION IN WORD L FROM OR TO THE LOW ORDER
C        NUMERIC POSITION.
C
C        COMMON VARIABLES USED - CDLN,CPW,IERR,L,MAXN,SHFT,ITMP
C
C        SUBROUTINES REQUIRED  - NONE
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER       CPW,CDLN,SHFT
      EQUIVALENCE  (I,IPOS,ITMP)
C
C
C--------TEST REQUESTED CODE POSITION.  MUST LIE WITHIN DEFINED
C        BOUNDARY OF CODE WORD STRUCTURE.
      IF(N.LE.0) GO TO 10
      IF(N.GT.MAXN) GO TO 20
C
C--------NORMAL RETURN.  SET ERROR CODE AND FUNCTION VALUE.
      IERR=0
      ECHK=.FALSE.
C
C--------COMPUTE WORD ADDRESS (L) WITHIN CODE LIST ARRAY, AND POSITION
C        ADDRESS (IPOS) WITHIN WORD L FOR CODE LOCATION N.
      I=N-1
      L=I/CPW
      IPOS=I-L*CPW
      L=L+1
C
C--------COMPUTE SHIFT FACTOR TO ACCESS CODE N IN POSITION IPOS OF
C        WORD L.
      I=CDLN*IPOS
      SHFT=2**I
      RETURN
C
C--------ERROR RETURNS.
   10 IERR=3
      GO TO 30
   20 IERR=4
   30 ECHK=.TRUE.
      RETURN
      END
      SUBROUTINE RSET(CODE,N)
C
C        SUBROUTINE RSET (FOR RESET) IS USED TO CLEAR (I.E., SET TO
C        ZERO) CODE POSITION N FOR MULTIPLY VALUED CODES STORED IN AN
C        ARRAY.  DEFINITION OF THE PACKED CODE STRUCTURE IS OBTAINED
C        FROM THE MOST RECENT CALL TO SUBROUTINE INIT.  IF N IS INVALID,
C        IERR IS SET TO 3 OR 4 ON RETURN AND CODE IS UNCHANGED.  OTHER-
C        WISE IERR=0 ON RETURN, AND ALL BITS WITHIN CODE N ARE RESET.
```

```
C
C        COMMON VARIABLES USED - ITMP,L,MAXV,SHFT
C
C        SUBROUTINES REQUIRED  - ECHK
C
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER      CPW,SHFT,CDLN
C
      INTEGER      CODE(1)
      LOGICAL      ECHK
C
C
C--------CHECK ARGUMENT N, RETURN IF ERROR.
      IF(ECHK(N)) RETURN
C
C--------MOVE MAXIMUM VALUE (ALL BITS SET) TO SHIFTED POSITION IN CODE.
      ITMP=MAXV*SHFT
C
C--------RESET THIS POSITION IN WORD L OF CODE ARRAY.
      CODE(L)=(.NOT.ITMP).AND.CODE(L)
      RETURN
      END
      SUBROUTINE SET(CODE,N,IVAL)
C
C        SUBROUTINE SET STORES THE INTEGER VALUE IVAL AS A CODED
C        VALUE IN CODE POSITION N OF THE ARRAY CODE.  DEFINITION OF
C        THE PACKED CODE STRUCTURE IS OBTAINED FROM THE MOST RECENT
C        CALL TO SUBROUTINE INIT.  SUBROUTINE SET FIRST CLEARS THE
C        VALUE IN CODE POSITION N AND THEN STORES IVAL IF THE ARGUMENT
C        IS AN ACCEPTABLE CODE VALUE IN THE RANGE 1 TO MAXV.  IF IVAL
C        IS LESS THAN ZERO, CODE N IS SET TO ZERO AND IERR=5 ON RETURN.
C        IF IVAL EXCEEDS MAXV, CODE N IS SET TO MAXV AND IERR=6 ON
C        RETURN.  IERR MAY ALSO BE SET TO 3 OR 4 IF N IS INVALID AND
C        IN THIS CASE CODE IS UNCHANGED ON RETURN.  IERR IS ZERO ON
C        NORMAL RETURN WITH NO ERRORS.
C
C        COMMON VARIABLES USED - IERR,ITMP,L,MAXV,SHFT
C
C        SUBROUTINES REQUIRED  - RSET
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER      CPW,SHFT,CDLN
C
      INTEGER      CODE(1)
C
C
C--------RESET CODE STORED IN POSITION N AND RETURN IF ERROR ENCOUNTERED
      CALL RSET(CODE,N)
      IF(IERR.NE.0) RETURN
C
C--------RETURN AFTER RESET IF IVAL IS LESS THAN OR EQUAL TO ZERO.  IF
C        IVAL IS LESS THAN ZERO ALSO SET ERROR FLAG.
      IF(IVAL.LT.0) IERR=5
      IF(IVAL.LE.0) RETURN
C
C--------TEST FOR INPUT ARGUMENT LARGER THAN MAXIMUM ALLOWED CODED VALUE
      IF(IVAL.GT.MAXV) GO TO 20
C
C--------MOVE CODED VALUE TO POSITION WITHIN WORD L OF CODED ARRAY,
C        STORE AND RETURN.
      ITMP=IVAL*SHFT
   10 CODE(L)=ITMP.OR.CODE(L)
      RETURN
C
C--------IVAL EXCEEDS MAXIMUM ALLOWED CODED VALUE.  SET ERROR FLAG THEN
C        STORE MAXIMUM VALUE.
   20 IERR=6
      ITMP=MAXV*SHFT
      GO TO 10
      END
```

```
      FUNCTION ITST(CODE,N)
C
C        FUNCTION ITST RETURNS THE INTEGER VALUE OF CODE N STORED IN
C        A PACKED ARRAY CODE.  IF N IS NOT WITHIN THE RANGE OF THE
C        PACKED CODES, A VALUE OF ZERO IS RETURNED FOR ITST AND IERR
C        IS SET TO 3 OR 4.  IF N IS VALID, THE VALUE OF ITST IS OBTAINED
C        FROM THE PACKED CODE IN POSITION N IN THE RANGE 0 TO MAXV, AND
C        IERR IS RETURNED AS ZERO.  DEFINITION OF THE PACKED CODE
C        STRUCTURE IS OBTAINED FROM THE MOST RECENT CALL TO SUB-
C        ROUTINE INIT.
C
C        COMMON VARIABLES USED - ITMP,L,MAXV,SHFT
C
C        SUBROUTINES REQUIRED  - ECHK
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER      CPW,SHFT,CDLN
C
      INTEGER      CODE(1)
      LOGICAL      ECHK
C
C
C--------INITIALIZE FUNCTION VALUE AND RETURN IF N IS INVALID.
      ITST=0
      IF(ECHK(N)) RETURN
C
C--------MOVE CODED VALUE IN WORD L TO LOW ORDER POSITION OF ITMP.
      ITMP=CODE(L)/SHFT
C
C--------OBTAIN CODED VALUE BY REMOVING ANY BITS REMAINING IN HIGHER
C        ORDER POSITIONS.
      ITST=ITMP.AND.MAXV
      RETURN
      END
      SUBROUTINE PACK(IAR,CODE)
C
C        SUBROUTINE PACK TRANSFERS DATA VALUES FROM THE INPUT ARRAY
C        IAR TO COMPRESSED FORMAT IN THE ARRAY CODE.  THE PARAMETERS
C        OF THE COMPACTION MUST BE SET BY CALLING SUBROUTINE INIT WITH
C        THE ARRAY CODE AS AN ARGUMENT PRIOR TO EACH NEW USE OF THIS
C        ROUTINE.  IF AN ERROR IS DETECTED BY SUBROUTINE INIT, THE
C        CONTENTS OF THE OUTPUT ARRAY CODE ARE UNCHANGED.
C
C        IF NO ERRORS HAVE OCCURRED DURING INITIALIZATION, THE FIRST
C        MAXN VALUES IN IAR ARE MOVED TO PACKED POSITIONS IN CODE.
C        THE VALUES IN IAR ARE ASSUMED TO BE IN THE RANGE 0 TO MAXV.
C        IF A NEGATIVE VALUE IS ENCOUNTERED, THE ERROR FLAG IERR IS
C        SET TO 5, AND A CODE VALUE OF ZERO IS STORED.  IF A VALUE IN
C        IAR IS GREATER THAN MAXV, THEN IERR IS SET TO 6 AND A CODE
C        VALUE OF MAXV IS STORED.  ON RETURN, IERR WILL BE ZERO (NO
C        ERROR) OR SET TO THE LAST ERROR CONDITION (5 OR 6) ENCOUNTERED.
C
C        BASE   = INTEGER QUANTITY USED AS A MULTIPLIER TO SHIFT
C                    PACKED VALUE BY ONE CODE POSITION.
C        I      = INDEX TO PACKED CODE POSITION WITHIN SINGLE WORD
C                    OF ARRAY CODE, VARIES FROM 1 TO CPW.
C        IAR    = INPUT INTEGER ARRAY.  EACH WORD CONTAINS SINGLE
C                    VALUE IN RANGE 0 TO MAXV TO BE PACKED INTO CODE.
C                    ARRAY MUST BE DIMENSIONED IN CALLING PROGRAM TO
C                    LENGTH OF MAXN OR GREATER.
C        J      = INDEX TO ELEMENTS OF IAR TO BE PACKED, VARIES FROM
C                    1 TO MAXN.
C
C        COMMON VARIABLES USED - CPW,IERR,ITMP,L,MAXN,MAXV,SHFT
C
C        SUBROUTINES REQUIRED  - INIT (PRIOR CALL)
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER      CPW,CDLN,SHFT
C
```

```
      INTEGER      BASE,CODE(1)
      DIMENSION    IAR(1)
C
C
C--------RETURN IF ERROR FLAG INDICATES PARAMETERS OF DATA COMPRESSION
C        NOT STORED IN COMMON, OTHERWISE INITIALIZE PACKING SEQUENCE.
      IF(IERR.NE.0) RETURN
      I=CPW
      L=0
      BASE=MAXV+1
C
C--------OVERALL LOOP ON MAXN ELEMENTS OF IAR TO BE PACKED INTO CODE
      DO 40 J=1,MAXN
C
C--------INCREMENT POSITION INDEX I.  ADJUST SHIFT FACTOR TO NEXT
C        POSITION IF STILL IN SAME WORD.  IF CURRENT WORD IS FULL, SET
C        TO PACK INTO FIRST POSITION OF NEXT WORD.
      I=I+1
      IF(I.LE.CPW) GO TO 10
      L=L+1
      SHFT=1
      I=1
      GO TO 20
   10 SHFT=SHFT*BASE
C
C--------MOVE CURRENT VALUE IN IAR TO ITMP AND TEST MAGNITUDE.  STORE
C        ONLY VALUES IN RANGE 0 TO MAXV.  SET IERR TO 5 OR 6 IF IAR(J)
C        IS OUTSIDE THIS RANGE, AND SET ITMP TO MAXV FOR IERR=6.
   20 ITMP=IAR(J)
      IF(ITMP.LT.0) IERR=5
      IF(ITMP.LE.0) GO TO 40
      IF(ITMP.LE.MAXV) GO TO 30
      IERR=6
      ITMP=MAXV
C
C--------SHIFT CODE VALUE IN ITMP TO PACKED POSITION, STORE IN CODED
C        ARRAY AND CONTINUE TO END OF LOOP ON VALUES IN IAR INPUT ARRAY.
   30 ITMP=ITMP*SHFT
      CODE(L)=CODE(L).OR.ITMP
   40 CONTINUE
      RETURN
      END
      SUBROUTINE UNPK(CODE,IAR)
C
C        SUBROUTINE UNPK MOVES CODED VALUES STORED IN ARRAY CODE TO
C        UNPACKED INTEGER FORMAT IN ARRAY IAR.  THE PARAMETERS OF THE
C        COMPACTION MUST BE OBTAINED BY CALLING SUBROUTINE INIT WITH
C        THE ARRAY IAR AS AN ARGUMENT PRIOR TO EACH NEW USE OF THIS
C        ROUTINE.  CODED VALUES PACKED IN THE ARRAY CODE ARE RETURNED
C        AS MAXN INTEGER VALUES, EACH IN THE RANGE 0 TO MAXV, STORED
C        IN WORDS 1 TO MAXN OF IAR.  NO ERROR CONDITIONS ARE SET BY
C        THIS ROUTINE.
C
C        I      = INDEX TO PACKED VALUE POSITION WITHIN SINGLE WORD
C                    OF ARRAY CODE, VARIES FROM 1 TO CPW.
C        IAR    = OUTPUT ARRAY FILLED ON RETURN WITH MAXN VALUES
C                    UNPACKED FROM INPUT ARRAY CODE.  MUST BE DIMENSIONED
C                    IN CALLING PROGRAM TO LENGTH OF MAXN OR GREATER.
C        J      = INDEX TO ELEMENTS OF IAR TO BE FILLED, VARIES FROM
C                    1 TO MAXN.
C
C        COMMON VARIABLES USED - CPW,IERR,ITMP,L,MAXN,MAXV,SHFT
C
C        SUBROUTINES REQUIRED  - INIT (PRIOR CALL)
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN,CDLN,MAXV
      INTEGER      CPW,SHFT,CDLN
C
      INTEGER      CODE(1)
      DIMENSION    IAR(1)
C
```

```
C
C--------RETURN IF ERROR FLAG INDICATES PARAMETERS OF DATA COMPRESSION
C           NOT STORED IN COMMON, OTHERWISE INITIALIZE UNPACKING SEQUENCE.
      IF(IERR.NE.0) RETURN
      L=0
      I=CPW
      SHFT=MAXV+1
C
C--------OVERALL LOOP ON ELEMENTS OF IAR TO BE FILLED.
      DO 30 J=1,MAXN
C
C--------INCREMENT INDEX TO PACKED POSITION IN WORD OF ARRAY CODE.  IF
C           POSITIONED BEYOND CPW, SELECT FIRST POSITION OF NEXT WORD
C           AND STORE ENTIRE CODE WORD IN ITMP.  IF POSITIONED WITHIN
C           CURRENT WORD, SHFT CODE IN ITMP TO LOW-ORDER POSITION.
      I=I+1
      IF(I.LE.CPW) GO TO 10
      L=L+1
      ITMP=CODE(L)
      I=1
      GO TO 20
   10 ITMP=ITMP/SHFT
C
C--------MOVE CODED VALUE INTO IAR, AND CONTINUE CYCLE UNTIL ALL
C           ELEMENTS HAVE BEEN UNPACKED.
   20 IAR(J)=ITMP.AND.MAXV
   30 CONTINUE
      RETURN
      END
C
C
C         ****************************************************************
C         *                                                              *
C         *                  LEVEL 2 PROGRAM LISTINGS                    *
C         *                                                              *
C         ****************************************************************
C
C
      SUBROUTINE INITM(CODE,I,J)
C
C         SUBROUTINE INITM IS A SUB-SET OF SUBROUTINE INIT EQUIVALENT
C         TO AND REPLACEABLE BY INIT(CODE,I,J,1).  THAT IS, THIS ROUTINE
C         FIXES THE LENGTH OF PACKED CODED VALUES, K, TO 1 FOR SINGLE
C         BIT CODING IN AN INTEGER ARRAY.  PROGRAM CODING IS SIMPLIFIED,
C         BUT ALL OTHER FUNCTIONS AND USE REMAIN UNCHANGED.  REFER TO
C         LISTING OF SUBROUTINE INIT FOR ADDITIONAL INFORMATION.  ON
C         RETURN, THE ERROR FLAG IERR IS SET TO ZERO (NO ERRORS) OR TO
C         1,2 OR 7.
C
C         COMMON VARIABLES USED - CPW,IERR,L,MAXN
C
C         SUBROUTINES REQUIRED  - NONE
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN
      INTEGER      CPW,SHFT
C
      INTEGER      CODE(1)
      DATA         MXWRD/47/
C
C
C--------TEST LENGTH OF WORD TO BE USED FOR CODE STORAGE.  CANNOT BE
C           LESS THAN 1 OR EXCEED MAXIMUM UNSIGNED INTEGER WORD LENGTH.
      IF(I.LE.0) GO TO 20
      IF(I.GT.MXWRD) GO TO 30
C
C--------TEST NUMBER OF WORDS TO BE USED FOR CODE STORAGE.  CANNOT BE
C           LESS THAN 1.  UPPER LIMIT IS NOT TESTED SINCE THIS IS
C           CONTROLLED BY USER DIMENSION IN CALLING PROGRAM.
      IF(J.LE.0) GO TO 40
C
C--------NORMAL RETURN.  SAVE NUMBER OF CODES TO BE STORED PER WORD
```

```
C        (CPW), INITIALIZE ALL CODE WORDS TO ZERO, AND SET NORMAL ERROR
C        RETURN.  COMPUTE TOTAL NUMBER OF CODES WHICH CAN BE STORED
C        (MAXN).
      IERR=0
      CPW=I
      DO 10 L=1,J
   10 CODE(L)=0
      MAXN=CPW*J
      RETURN
C
C--------ERROR RETURNS.  SET VALUE OF ERROR SWITCH IN COMMON AND
C        DEFAULT TO CODE DEFINITION USING SINGLE WORD CONTAINING CODES
C        ONE BIT IN LENGTH.
   20 IERR=1
      GO TO 70
   30 IERR=2
      GO TO 70
   40 IERR=7
   70 CPW=MXWRD
      CODE(1)=0
      MAXN=MXWRD
      RETURN
      END
      LOGICAL FUNCTION ECHKM(N)
C
C        LOGICAL FUNCTION ECHKM IS A SUB-SET OF LOGICAL FUNCTION ECHK.
C        IN THIS VERSION, THE FUNCTION ASSUMES THE LENGTH OF CODED
C        VALUES IS SET TO 1 FOR PACKING SINGLE BIT CODES INTO AN
C        INTEGER ARRAY.  PROGRAM CODING IS SLIGHTLY SIMPLIFIED, BUT
C        ALL OTHER FUNCTIONS AND USE REMAIN UNCHANGED.  REFER TO
C        LISTING OF FUNCTION ECHK FOR ADDITIONAL INFORMATION.  NOTE
C        THAT THE ECHK FUNCTIONS ARE ONLY USED INTERNALLY BY THE
C        PACKING AND UNPACKING ROUTINES, AND CALLS TO ECHK, ECHKM
C        AND ECHK1 ARE NOT INTERCHANGEABLE.  ON RETURN FROM ECHKM,
C        THE ERROR FLAG IERR IS SET TO ZERO (NO ERRORS) OR TO 3 OR 4.
C
C        COMMON VARIABLES USED - CPW,IERR,ITMP,L,MAXN,SHFT
C
C        SUBROUTINES REQUIRED  - NONE
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN
      INTEGER      CPW,SHFT
      EQUIVALENCE  (I,IPOS,ITMP)
C
C
C--------TEST REQUESTED CODE POSITION.  MUST LIE WITHIN DEFINED
C        BOUNDARY OF CODE WORD STRUCTURE.
      IF(N.LE.0) GO TO 10
      IF(N.GT.MAXN) GO TO 20
C
C--------NORMAL RETURN.  SET ERROR CODE AND FUNCTION VALUE.
      IERR=0
      ECHKM=.FALSE.
C
C--------COMPUTE WORD ADDRESS (L) WITHIN CODE LIST ARRAY, AND POSITION
C        ADDRESS (IPOS) WITHIN WORD L FOR CODE LOCATION N.
      I=N-1
      L=I/CPW
      IPOS=I-L*CPW
      L=L+1
C
C--------COMPUTE SHIFT FACTOR TO ACCESS CODE N IN POSITION IPOS OF
C        WORD L.
      SHFT=2**IPOS
      RETURN
C
C--------ERROR RETURNS.
   10 IERR=3
      GO TO 30
   20 IERR=4
   30 ECHKM=.TRUE.
```

```
      RETURN
      END
      SUBROUTINE RSETM(CODE,N)
C
C        SUBROUTINE RSETM IS A SUB-SET OF SUBROUTINE RSET USED FOR
C        SINGLE BIT CODES STORED WITHIN AN ARRAY, AND PROGRAM CODE
C        IS SOMEWHAT SIMPLIFIED.  BIT N IS RESET IF SET, UNCHANGED IF
C        NOT SET.  ON RETURN, IERR WILL BE SET TO 3 OR 4 IF N IS
C        INVALID, OR ZERO IF N IS VALID.
C
C        COMMON VARIABLES USED - L,SHFT
C
C        SUBROUTINES REQUIRED  - ECHKM
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN
      INTEGER       CPW,SHFT
C
      INTEGER       CODE(1)
      LOGICAL       ECHKM
C
C
C--------CHECK ARGUMENT N, RETURN IF ERROR.
      IF(ECHKM(N)) RETURN
C
C--------USE COMPUTED WORD LOCATION AND SHIFT FACTOR TO RESET BIT N.
      CODE(L)=(.NOT.SHFT).AND.CODE(L)
      RETURN
      END
      SUBROUTINE SETM(CODE,N)
C
C        SUBROUTINE SETM IS A SUB-SET OF SUBROUTINE SET USED TO SET
C        SINGLE BIT CODED VALUES STORED WITHIN AN ARRAY.  SINCE ONLY
C        A SINGLE VALUE CAN BE SET (I.E., 1), THE ARGUMENT IVAL IS
C        ELIMINATED AND PROGRAM CODING IS GREATLY SIMPLIFIED.  SUB-
C        ROUTINE SETM WILL SET CODE POSITION N TO 1 IF UNSET, OR LEAVE
C        IT UNCHANGED IF ALREADY SET.  ON RETURN, IERR WILL BE SET
C        TO 3 OR 4 IF N IS INVALID, AND CODE IS UNCHANGED ON RETURN.
C        OTHERWISE, IERR=0 ON NORMAL RETURN.
C
C        COMMON VARIABLES USED - L,SHFT
C
C        SUBROUTINES REQUIRED  - ECHKM
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN
      INTEGER       CPW,SHFT
C
      INTEGER       CODE(1)
      LOGICAL       ECHKM
C
C
C--------CHECK ARGUMENT N, RETURN IF ERROR.
      IF(ECHKM(N)) RETURN
C
C--------USE ARRAY WORD LOCATION L AND SHIFT TO CODE POSITION, SHFT,
C        COMPUTED BY ECHKM TO SET BIT N.
      CODE(L)=SHFT.OR.CODE(L)
      RETURN
      END
      FUNCTION ITSTM(CODE,N)
C
C        FUNCTION ITSTM IS A SUB-SET OF FUNCTION ITST IN WHICH SINGLE
C        BIT CODES ARE STORED IN AN ARRAY OF PACKED CODES.  ON RETURN,
C        ITSTM=1 IF BIT N IS SET, ZERO OTHERWISE.  IF N IS NOT WITHIN
C        THE RANGE OF PACKED CODES, A VALUE OF ZERO IS RETURNED FOR
C        ITSTM AND IERR IS SET TO 3 OR 4.  IF N IS VALID, IERR IS
C        RETURNED AS ZERO.
C
C        COMMON VARIABLES USED - ITMP,L,SHFT
C
C        SUBROUTINES REQUIRED  - ECHKM
```

```
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN
      INTEGER       CPW,SHFT
C
      INTEGER       CODE(1)
      LOGICAL       ECHKM
C
C
C--------INITIALIZE FUNCTION VALUE AND RETURN IF N IS INVALID.
      ITSTM=0
      IF(ECHKM(N)) RETURN
C
C--------MOVE CODED VALUE IN WORD L TO LOW ORDER POSITION OF ITMP.
      ITMP=CODE(L)/SHFT
C
C--------OBTAIN CODED VALUE BY STRIPPING OFF ANY HIGHER ORDER BITS
C           WHICH REMAIN.
      ITSTM=ITMP.AND.1
      RETURN
      END
      SUBROUTINE PACKM(IAR,CODE)
C
C           SUBROUTINE PACKM IS A SUB-SET OF SUBROUTINE PACK IN WHICH
C           VALUES STORED IN THE ARRAY IAR ARE PACKED INTO THE CODE WORD
C           ARRAY CODE.  PACKM ASSUMES THAT THE VALUES STORED IN IAR ON
C           INPUT ARE ZERO OR ONE SO THAT ONLY SINGLE BIT VALUES ARE
C           PACKED INTO ARRAY CODE.  THE PARAMETERS OF THE COMPACTION MUST
C           BE SET BY CALLING SUBROUTINE INITM WITH THE ARRAY CODE AS AN
C           ARGUMENT PRIOR TO EACH NEW USE OF THIS ROUTINE.  ERROR CON-
C           DITIONS IF A VALUE IN IAR IS LESS THAN ZERO OR GREATER THAN
C           1 ARE THE SAME AS IN SUBROUTINE PACK.
C
C           I,IAR,J = REFER TO LISTING OF SUBROUTINE PACK FOR DEFINITIONS
C
C           COMMON VARIABLES USED - CPW,IERR,ITMP,L,MAXN,SHFT
C
C           SUBROUTINES REQUIRED  - INITM (PRIOR CALL)
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN
      INTEGER       CPW,SHFT
C
      INTEGER       CODE(1)
      DIMENSION     IAR(1)
C
C
C--------RETURN IF ERROR FLAG INDICATES PARAMETERS OF DATA COMPRESSION
C           NOT STORED IN COMMON, OTHERWISE INITIALIZE PACKING SEQUENCE.
      IF(IERR.NE.0) RETURN
      I=CPW
      L=0
C
C--------OVERALL LOOP ON MAXN ELEMENTS OF IAR TO BE PACKED INTO CODE
      DO 40 J=1,MAXN
C
C--------INCREMENT POSITION INDEX I.  ADJUST SHIFT FACTOR TO NEXT
C           POSITION IF STILL IN SAME WORD.  IF CURRENT WORD IS FULL, SET
C           TO PACK INTO FIRST POSITION OF NEXT WORD.
      I=I+1
      IF(I.LE.CPW) GO TO 10
      L=L+1
      SHFT=1
      I=1
      GO TO 20
   10 SHFT=2*SHFT
C
C--------MOVE CURRENT VALUE IN IAR TO ITMP AND TEST MAGNITUDE.  STORE
C           ONLY VALUES 0 OR 1.  SET IERR TO 5 OR 6 IF IAR(J) IS NOT 0 OR 1
C           AND SKIP TO NEXT VALUE IF ITMP IS NOT GREATER THAN ZERO.
   20 ITMP=IAR(J)
      IF(ITMP.LT.0) IERR=5
```

```
      IF(ITMP.LE.0) GO TO 40
      IF(ITMP.GT.1) IERR=6
C
C--------STORE CODE VALUE IN PACKED POSITION AND CONTINUE TO END
C         OF LOOP ON VALUES IN IAR INPUT ARRAY.
      CODE(L)=CODE(L).OR.SHFT
   40 CONTINUE
      RETURN
      END
      SUBROUTINE UNPKM(CODE,IAR)
C
C         SUBROUTINE UNPKM IS A SUB-SET OF SUBROUTINE UNPK AND MOVES
C         SINGLE BIT CODED VALUES (0 OR 1) FROM A PACKED ARRAY CODE
C         TO AN UNPACKED INTEGER ARRAY IAR.  THE PARAMETERS OF THE
C         COMPACTION MUST BE OBTAINED BY CALLING SUBROUTINE INITM WITH
C         THE ARRAY IAR AS AN ARGUMENT PRIOR TO EACH NEW USE OF THIS
C         ROUTINE.  CODED VALUES PACKED IN THE ARRAY CODE ARE RETURNED
C         AS MAXN INTEGER VALUES, EACH 0 OR 1, STORED IN WORDS 1 TO MAXN
C         OF IAR.  NO ERROR CONDITIONS ARE SET BY THIS ROUTINE.
C
C         I,IAR,J = REFER TO LISTING OF SUBROUTINE UNPK FOR DEFINITIONS.
C
C         COMMON VARIABLES USED - CPW,IERR,ITMP,L,MAXN
C
C         SUBROUTINES REQUIRED  - INITM (PRIOR CALL)
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT,L,MAXN
      INTEGER       CPW,SHFT
C
      INTEGER       CODE(1)
      DIMENSION     IAR(1)
C
C
C--------RETURN IF ERROR FLAG INDICATES PARAMETERS OF DATA COMPRESSION
C         NOT STORED IN COMMON, OTHERWISE INITIALIZE UNPACKING SEQUENCE.
      IF(IERR.NE.0) RETURN
      L=0
      I=CPW
C
C--------OVERALL LOOP ON ELEMENTS OF IAR TO BE FILLED
      DO 30  =1,MAXN
C
C--------INCREMENT INDEX TO PACKED POSITION IN WORD OF ARRAY CODE.  IF
C         POSITIONED BEYOND CPW, SELECT FIRST POSITION OF NEXT WORD
C         AND STORE ENTIRE CODE WORD IN ITMP.  IF POSITIONED WITHIN
C         CURRENT WORD, SHIFT CODE IN ITMP TO LOW-ORDER POSITION.
      I=I+1
      IF(I.LE.CPW) GO TO 10
      L=L+1
      ITMP=CODE(L)
      I=1
      GO TO 20
   10 ITMP=ITMP/2
C
C--------MOVE CODED VALUE INTO IAR AND CONTINUE CYCLE UNTIL ALL ELEMENTS
C         HAVE BEEN UNPACKED.
   20 IAR(J)=ITMP.AND.1
   30 CONTINUE
      RETURN
      END
C
C
C         ***************************************************************
C         *                                                             *
C         *                  LEVEL 3 PROGRAM LISTINGS                   *
C         *                                                             *
C         ***************************************************************
C
C
      SUBROUTINE INIT1(CODE,I)
C
```

```
C        SUBROUTINE INIT1 IS A SUB-SET OF SUBROUTINES INIT AND INITM.
C        IT IS EQUIVALENT TO AND REPLACEABLE BY INIT(CODE,I,1,1) OR
C        INITM(CODE,I,1).  THAT IS, THIS ROUTINE FIXES THE LENGTH OF
C        PACKED CODED VALUES, K, TO 1 AS IN INITM, AND, IN ADDITION,
C        FIXES THE LENGTH OF THE ARRAY, J, TO 1 FOR STORAGE OF CODES
C        WITHIN A SINGLE WORD.  PROGRAM CODING IS SIMPLIFIED, BUT ALL
C        OTHER FUNCTIONS AND USE REMAIN UNCHANGED.  REFER TO LISTING OF
C        SUBROUTINE INIT FOR ADDITIONAL INFORMATION.  ON RETURN, THE
C        ERROR FLAG IERR IS SET TO ZERO (NO ERRORS) OR TO 1 OR 2.
C
C        COMMON VARIABLES USED - CPW,IERR
C
C        SUBROUTINES REQUIRED  - NONE
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT
      INTEGER      CPW,SHFT
C
      INTEGER      CODE
      DATA         MXWRD/47/
C
C
C--------TEST LENGTH OF WORD TO BE USED FOR CODE STORAGE.  CANNOT BE
C        LESS THAN 1 OR EXCEED MAXIMUM UNSIGNED INTEGER WORD LENGTH.
      IF(I.LE.0) GO TO 20
      IF(I.GT.MXWRD) GO TO 30
C
C--------NORMAL RETURN.  SAVE NUMBER OF CODES TO BE STORED IN SINGLE
C        CODE WORD (CPW), INITIALIZE CODE WORD TO ZERO AND SET NORMAL
C        ERROR RETURN.
      IERR=0
      CPW=I
   10 CODE=0
      RETURN
C
C--------ERROR RETURNS.  SET VALUE OF ERROR SWITCH IN COMMON AND
C        DEFAULT TO CODE DEFINITION FOR SINGLE WORD CONTAINING UP TO
C        MXWRD SINGLE BIT CODES.
   20 IERR=1
      GO TO 70
   30 IERR=2
   70 CPW=MXWRD
      GO TO 10
      END
      LOGICAL FUNCTION ECHK1(N)
C
C        LOGICAL FUNCTION ECHK1 IS A SUB-SET OF FUNCTIONS ECHK AND
C        ECHKM.  THAT IS, THE ROUTINE ASSUMES A FIXED LENGTH OF PACKED
C        CODED VALUES OF 1 AS IN ECHKM, AND, IN ADDITION, ASSUMES THAT
C        ALL PACKED CODED VALUES ARE STORED IN A SINGLE WORD, NOT IN AN
C        ARRAY.  PROGRAM CODING IS SIMPLIFIED, BUT THE BASIC FUNCTION
C        AND USE OF THE ROUTINE ARE UNCHANGED.  REFER TO LISTING OF
C        FUNCTION ECHK FOR ADDITIONAL INFORMATION.  ON RETURN FROM
C        ECHK1, THE ERROR FLAG IERR IS SET TO ZERO (NO ERRORS) OR TO
C        3 OR 4.
C
C        COMMON VARIABLES USED - CPW,IERR,ITMP,SHFT
C
C        SUBROUTINES REQUIRED  - NONE
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT
      INTEGER      CPW,SHFT
      EQUIVALENCE  (IPOS,ITMP)
C
C
C--------TEST REQUESTED CODE POSITION.  MUST LIE WITHIN DEFINED
C        BOUNDARY OF CODE WORD.  NOTE CPW EXCHANGED FOR MAXN.
      IF(N.LE.0) GO TO 10
      IF(N.GT.CPW) GO TO 20
C
C--------NORMAL RETURN.  SET ERROR CODE AND FUNCTION VALUE.
```

```
      IERR=0
      ECHK1=.FALSE.
C
C--------COMPUTE SHIFT FACTOR TO CODE N POSITION WITHIN SINGLE PACKED
C           CODE WORD.
      IPOS=N-1
      SHFT=2**IPOS
      RETURN
C
C--------ERROR RETURNS
   10 IERR=3
      GO TO 30
   20 IERR=4
   30 ECHK1=.TRUE.
      RETURN
      END
      SUBROUTINE RSET1(CODE,N)
C
C           SUBROUTINE RSET1 IS A SUB-SET OF SUBROUTINES RSET AND RSETM
C           USED FOR SINGLE BIT CODES STORED WITHIN A SINGLE CODE WORD.
C           PROGRAM CODE IS SOMEWHAT SIMPLIFIED.  BIT N IS RESET IF SET,
C           UNCHANGED IF NOT SET.  ON RETURN, IERR WILL BE SET TO 3 OR 4
C           IF N IS INVALID, ZERO OTHERWISE.
C
C           COMMON VARIABLES USED - SHFT
C
C           SUBROUTINES REQUIRED  - ECHK1
C
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT
      INTEGER      CPW,SHFT
C
      INTEGER      CODE
      LOGICAL      ECHK1
C
C
C--------CHECK ARGUMENT N, RETURN IF ERROR.
      IF(ECHK1(N)) RETURN
C
C--------USE COMPUTED SHIFT FACTOR TO RESET BIT N IN CODE WORD.
      CODE=(.NOT.SHFT).AND.CODE
      RETURN
      END
      SUBROUTINE SET1(CODE,N)
C
C           SUBROUTINE SET1 IS A SUB-SET OF SUBROUTINES SET AND SETM.  A
C           SINGLE BIT CODED VALUE IS SET WITHIN A SINGLE CODE WORD.  SINCE
C           ONLY A SINGLE VALUE CAN BE SET (I.E., 1), THE ARGUMENT IVAL IS
C           ELIMINATED AND PROGRAM CODING IS GREATLY SIMPLIFIED.  SUB-
C           ROUTINE SET1 WILL SET CODE POSITION N TO 1 IF UNSET, OR LEAVE
C           IT UNCHANGED IF ALREADY SET.  ON RETURN, IERR WILL BE SET TO
C           3 OR 4 IF N IS INVALID, AND CODE IS UNCHANGED ON RETURN.
C           OTHERWISE IERR=0 ON NORMAL RETURN.
C
C           COMMON VARIABLES USED - SHFT
C
C           SUBROUTINES REQUIRED  - ECHK1
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT
      INTEGER      CPW,SHFT
C
      INTEGER      CODE
      LOGICAL      ECHK1
C
C
C--------CHECK ARGUMENT N, RETURN IF ERROR.
      IF(ECHK1(N)) RETURN
C
C--------USE SHIFT TO CODE POSITION N COMPUTED BY ECHK1 TO SET BIT N.
      CODE=SHFT.OR.CODE
      RETURN
```

```
      END
      FUNCTION ITST1(CODE,N)
C
C        FUNCTION ITST1 IS A SUB-SET OF FUNCTIONS ITST AND ITSTM IN *
C        WHICH SINGLE BIT CODES ARE STORED IN A SINGLE PACKED CODE WORD.
C        ON RETURN, ITST1=1 IF BIT N IS SET, ZERO OTHERWISE.  IF N IS
C        NOT WITHIN THE RANGE OF PACKED CODES, A VALUE OF ZERO IS
C        RETURNED FOR ITST1 AND IERR IS SET TO 3 OR 4.  IF N IS VALID,
C        IERR IS RETURNED AS ZERO.
C
C        COMMON VARIABLES USED - ITMP,SHFT
C
C        SUBROUTINES REQUIRED  - ECHK1
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT
      INTEGER      CPW,SHFT
C
      INTEGER      CODE
      LOGICAL      ECHK1
C
C
C--------INITIALIZE FUNCTION VALUE AND RETURN IF N IS INVALID.
      ITST1=0
      IF(ECHK1(N)) RETURN
C
C--------MOVE CODED VALUE IN CODE WORD TO LOW ORDER POSITION OF ITMP.
      ITMP=CODE/SHFT
C
C--------OBTAIN CODED VALUE BY STRIPPING OFF ANY HIGHER ORDER BITS
C        WHICH REMAIN.
      ITST1=ITMP.AND.1
      RETURN
      END
      SUBROUTINE PACK1(IAR,CODE)
C
C        SUBROUTINE PACK1 IS A SUB-SET OF SUBROUTINES PACK AND PACKM.
C        THAT IS, INPUT VALUES OF ZERO OR ONE STORED IN THE ARRAY IAR
C        ARE PACKED INTO A SINGLE WORD, CODE.  THE PARAMETERS OF THE
C        COMPACTION MUST BE SET BY CALLING SUBROUTINE INIT1 WITH CODE
C        AS AN ARGUMENT PRIOR TO EACH NEW USE OF THIS ROUTINE.  ERROR
C        CONDITIONS IF A VALUE IN IAR IS LESS THAN ZERO OR GREATER THAN
C        1 ARE THE SAME AS IN SUBROUTINE PACK.
C
C        IAR,J  = REFER TO LISTING OF SUBROUTINE PACK FOR DEFINITIONS
C
C        COMMON VARIABLES USED - CPW,IERR,ITMP,SHFT
C
C        SUBROUTINES REQUIRED  - INIT1 (PRIOR CALL)
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT
      INTEGER      CPW,SHFT
C
      INTEGER      CODE
      DIMENSION    IAR(1)
C
C
C--------RETURN IF ERROR FLAG INDICATES PARAMETERS OF DATA COMPRESSION
C        NOT STORED IN COMMON, OTHERWISE INITIALIZE PACKING SEQUENCE.
      IF(IERR.NE.0) RETURN
      J=1
      SHFT=1
C
C--------RETURN HERE FOR EACH NEXT VALUE IN IAR TO BE PACKED.  MOVE
C        VALUE FROM IAR TO ITMP AND TEST MAGNITUDE.  STORE ONLY VALUES
C        0 OR 1.  SET IERR TO 5 OR 6 IF IAR(J) IS NOT 0 OR 1 AND THEN
C        SKIP TO NEXT VALUE IF ITMP IS NOT GREATER THAN ZERO.
   10 ITMP=IAR(J)
      IF(ITMP.LT.0) IERR=5
      IF(ITMP.LE.0) GO TO 30
      IF(ITMP.GT.1) IERR=6
```

```
C
C--------STORE CODE VALUE IN PACKED POSITION.
      CODE=CODE.OR.SHFT
C
C--------INCREMENT INDEX TO INPUT WORDS IN IAR.  RETURN AFTER CPW WORDS
C           HAVE BEEN PACKED, OTHERWISE INCREMENT SHIFT FACTOR AND CONTINUE
C           CYCLE TO PACK NEXT VALUE.
   30 J=J+1
      IF(J.GT.CPW) RETURN
      SHFT=2*SHFT
      GO TO 10
      END
      SUBROUTINE UNPK1(CODE,IAR)
C
C           SUBROUTINE UNPK1 IS A SUB-SET OF SUBROUTINES UNPK AND UNPKM
C           AND MOVES SINGLE BIT CODED VALUES (0 OR 1) FROM A SINGLE
C           PACKED WORD (CODE) TO AN UNPACKED INTEGER ARRAY IAR.  THE
C           PARAMETERS OF THE COMPACTION MUST BE OBTAINED BY CALLING
C           SUBROUTINE INIT1 WITH THE ARRAY IAR AS AN ARGUMENT PRIOR TO
C           EACH NEW USE OF THIS ROUTINE.  CODED VALUES PACKED IN THE
C           SINGLE WORD CODE ARE RETURNED AS CPW INTEGER VALUES, EACH 0 OR
C           1, STORED IN WORDS 1 TO CPW OF IAR.  NO ERROR CONDITIONS ARE
C           SET BY THIS ROUTINE.
C
C           IAR,J  = REFER TO LISTING OF SUBROUTINE UNPK FOR DEFINITIONS.
C
C           COMMON VARIABLES USED - CPW,IERR,ITMP
C
C           SUBROUTINES REQUIRED  - INIT1 (PRIOR CALL)
C
C
      COMMON/GCODE/IERR,CPW,ITMP,SHFT
      INTEGER      CPW,SHFT
C
      INTEGER      CODE
      DIMENSION    IAR(1)
C
C
C--------RETURN IF ERROR FLAG INDICATES PARAMETERS OF DATA COMPRESSION
C           NOT STORED IN COMMON, OTHERWISE MOVE CODE WORD TO TEMPORARY
C           LOCATION FOR MANIPULATION.
      IF(IERR.NE.0) RETURN
      ITMP=CODE
C
C--------LOOP ON ELEMENTS OF IAR TO BE FILLED.  SET EACH TO LOW-ORDER
C           VALUE OF ITMP, THEN SHIFT ITMP ONE POSITION.  CONTINUE LOOP
C           UNTIL ALL CPW ELEMENTS OF IAR ARE SET.
      DO 10 J=1,CPW
      IAR(J)=ITMP.AND.1
   10 ITMP=ITMP/2
      RETURN
      END
C
C
C           ****************************************************************
C           *                                                              *
C           *                             END                              *
C           *                                                              *
C           ****************************************************************
READY.
```

7.4.2 Tab Key (File SAVCNV)

```
      PROGRAM CNV(TAPE10,TAPE11)
      INTEGER BLK,BUFF(80),COM,OUTR(80),TAB
      DATA BLK/1H /,COM/1HC/,TAB/1H^/
      REWIND 11
   10 READ(10,1000) BUFF
 1000 FORMAT (80A1)
      IF(EOF(10)) 90,15
   15 CONTINUE
      IF(BUFF(1).NE.COM) GO TO 50
      OUTB(1)=COM
      IF(BUFF(2).NE.TAB) GO TO 40
      DO 20 I=2,9
   20 OUTB(I)=BLK
      M=10
      N=4
      IF(BUFF(4).NE.TAB) GO TO 80
      DO 30 I=10,20
   30 OUTB(I)=BLK
      M=21
      N=6
      GO TO 80
   40 M=2
      N=2
      GO TO 80
   50 IF(BUFF(1).NE.TAB) GO TO 70
      DO 60 I=1,6
   60 OUTB(I)=BLK
      M=7
      N=3
      GO TO 80
   70 M=1
      N=1
   80 OUTB(M)=BUFF(N)
      M=M+1
      N=N+1
      IF(M.LE.80) GO TO 80
      WRITE(11,1010) OUTB
 1010 FORMAT (80A1)
      GO TO 10
   90 ENDFILE 11
      REWIND 11
      END
READY.
```

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